The 51st Annual Meeting of the Israeli Polymers & Plastics Society (IPPS 2026)

Guy Mechrez – IPPS President
Lucy Liberman & Jasmine Rosen Kligvasser – IPPS2026 Conference Chairs

WELCOME LETTER

Dear Colleagues,

We are delighted to welcome you to the 51st Annual Meeting of the Israeli Polymers & Plastics Society (IPPS 2026).

The conference is taking place on January 7th, 2026, at Expo Tel Aviv, featuring presentations that highlight cutting-edge research and recent advances across polymer science, materials science, and the plastics industry.

We extend our sincere thanks to the scientific committees for assembling an outstanding program of invited speakers, contributed talks, and poster presentations. We are especially honored to welcome our two distinguished keynote speakers:
Prof. Michael Gradzielski (Technische Universität Berlin) and Prof. Hsin-Lung Chen (National Tsing Hua University, Taiwan), who will share their research with us.

We encourage you to attend the poster session and engage with the presenters to learn more about their exciting work.

We hope you find the meeting intellectually stimulating, professionally rewarding, and an excellent opportunity to connect with colleagues and experts from across the country.

Warm regards,

On behalf of the IPPS Board and the IPPS 2026 Organizing Committee

Guy Mechrez – IPPS President
Lucy Liberman & Jasmine Rosen Kligvasser – IPPS2026 Conference Chairs

ORGANIZING COMMITTEE

Lucy Liberman, Conference Chair, *Technion – Israel Institute of Technology*

Jasmine Rosen Kligvasser, Conference Chair, *Plaskolite*

PROGRAM COMMITTEE

Charles Diesendruck, *Technion – Israel Institute of Technology*

Gali Fichman, *Hebrew University of Jerusalem*

Liel Sapir, *Bar-Ilan University*

Yanir Shaked, *Plastics-App*

Rotem Shemesh, *Carmel Olefins*

Yulia Shitrit

Zvi Yaari, *Hebrew University of Jerusalem*

Tal

CONFERENCE SECRETARIAT

Orit Gilad, *Diesenhaus Unitours*

Jennifer Simon Weisberg, *Diesenhaus Unitours*

07:30 - 09:00 Registration, Breakfast, Poster Mounting, Registration Area, Foyer, Poster Area

09:00 - 09:10 Opening Statement

HALL LM

09:10 - 09:35 Lifetime Achievement Award and Lecture

HALL LM

Chair: **Rotem Shemesh**, *Carmel Olefins*

09:35 - 10:55 Keynote Lectures

Hall LM

Chair: **Lucy Liberman**, *Technion - Israel Institute of Technology*

09:35 - 10:15 Investigation of structure and solubilisation properties of interpoly-electrolyte complexes (IPECs) - effect of hydrophobic modification

Michael Gradzielski, *Technische Universität Berlin, Germany*

10:15 - 10:55 Unraveling complex spherical packing in block copolymers

Hsin-Lung Chen, *National Tsing Hua University, Taiwan*

10:55 - 11:30 Coffee Break, Poster Viewing, Exhibition

Foyer, Poster Area

11:30 - 13:30 Polymer Chemistry

Hall LM

Chair: **Charles Diesendruck**, *Technion - Israel Institute of Technology*

11:30 - 11:55 *Invited Lecture:*
Ring opening polymerization by new catalysts: stereoselectivity, activity, and new polymeric microstructures

Moshe Kol, *Tel Aviv University*

11:55 - 12:20 *Invited Lecture:*
Polymeric chiral nanostructured materials

Yitzahk Mastai, *Bar-Ilan University*

12:20 - 12:45 *Invited Lecture:*
Flipping the script the Ben-Gurion way: two novel polymer classes via unconventional metathesis routes

Gabriel Lemcoff, *Ben-Gurion University of the Negev*

12:45 - 13:00 Emulsion-templated hierarchical porosities: Foaming, interpenetrating polymer networks, and hypercrosslinking

Kobi Avarjel, *Technion - Israel Institute of Technology*

13:00 - 13:15 Vapor-synthesized polyamide with angstrom-level precision for desalination membranes

Ruoke Cai, *Technion - Israel Institute of Technology*

13:15 - 13:30 Chemical grafting of polymers as a tool for fabrication of functional materials

Elizabeth Amir, *Shenkar - Engineering. Design. Art.*

11:30 - 13:30 Polymers in Medicine and Nanotechnology

Hall F

Chair: **Zvi Yaari**, *Hebrew University of Jerusalem*

11:30 - 11:55 *Invited Lecture:*
Living delivery system for the treatment of skin infections

Boaz Mizrahi, *Technion - Israel Institute of Technology*

11:55 - 12:20 *Invited Lecture:*
Biocompatible narrow size nanohydrogels for drug delivery

Gerardo Byk*, Bar Ilan University*

12:20 - 12:45 *Invited Lecture:*
TBA

Shady Farah, *Technion - Israel Institute of Technology*

12:45 - 13:00 Interactions of amphiphilic interpolyelectrolyte complexes with liposome membranes, studied by on-the-grid processing cryo-transmission electron microscopy

Sapir Rappoport, *Technion – Israel Institute of Technology*

13:00 - 13:15 Developing optical implantable matrices for clinical monitoring

Noemie Chekroune, *The Hebrew University of Jerusalem*

13:15 - 13:30 3D printing of personalized catheters with smart pH-responsive coating for improved functionality, cytocompatibility, and anti-bacterial characteristics

Eid Nassar-Marjiya, *Technion - Israel Institute of Technology*

11:30 - 13:30 Biopolymers and Bioplastics

Hall G

Chair: **Gali Fichman**, *The Hebrew University of Jerusalem*

11:30 - 11:55 *Invited Lecture:*
Engineering and functionalization of In Situ Injectable Gelatin Hydrogels for tissue regeneration applications

Meital Zilberman, *Tel-Aviv University*

11:55 - 12:20 *Invited Lecture:*
Algal protein-based 3D-printed fish-analogs as a new approach for sustainable seafood

Yoav D. Livney, *Technion - Israel Institute of Technology*

12:20 - 12:45 *Invited Lecture:*
Elucidating the role of root surface physical properties in root-environment interactions using biomimetics

Maya Kleiman, *Agricultural Research Organization (Volcani Center)*

12:45 - 13:00 Stretchability and melt strength enhancement of biodegradable polymer blends for packaging solutions

Katy Laevsky, *Shenkar - Engineering. Design. Art.*

13:00 - 13:15 Mussel-inspired chitosan hybrid films for multifunctional wet bioadhesion

Noam Rachel Avruch, *The Hebrew University of Jerusalem*

13:15 - 13:30 Atomic layer procesess for UV-stable polymers: synergistic effects of infiltration and deposition of ZnO

Gil Menasherov, *Technion - Israel Institute of Technology*

11:30 - 13:30 Polymer Processing and 3D Printing

Hall H

Chair: **Yanir Shaked**, *Plastics-App*

11:30 - 11:55 *Invited Lecture:*
UV crosslinking of polyethylene: from chemistry to packaging performance
Mark Shneider, *Kafrit IL*

11:55 - 12:20 *Invited Lecture:*
Nemo nanomaterials - turning nanotech into industrial advantage
Ilana Haymov, *Nemo Nanomaterials*

12:20 - 12:45 *Invited Lecture:*
Novel polyolefin vitrimer chemistry with improved melt processability: can we spare the crosslinker?
Naum Naveh, *Shenkar Engineering. Design. Art,*

12:45 - 13:00 3D printed omniphobic slippery liquid infused porous surfaces
Noa Trink, *The Hebrew University of Jerusalem*

13:00 - 13:15 Additive manufacturing of flexible strain sensors based on polymer nanocomposites
Oren Regev, *Ben Gurion University of the Negev*

13:15 - 13:30 Life cycle assessment of upcycling polyolefin waste to sustainable aviation fuel
Amir Shefy, *Technion - Israel Institute of Technology*

13:30 - 14:30 Lunch Break

Foyer

14:30 - 15:45 Poster Session

Poster Area

15:45 - 17:50 Polymer Physics

Hall LM

Chair: **Liel Sapir**, *Bar-Ilan University*

15:45 - 16:10 *Invited Lecture:*
Two-state theory of polymer glass transition - recent developments and successes

Valeriy Ginzburg, *Michigan State University, United States*

16:10 - 16:35 *Invited Lecture:*
Emulsion templating: DIY versatility for the creative design of porous polymers

Michael Silverstein, *Technion - Israel Institute of Technology*

16:35 - 17:00 *Invited Lecture:*
Effects of cross-linking on spatial organization and dynamics of confined associating polymers

Yitzhak Rabin, *Bar-Ilan University*

17:00 - 17:25 *Invited Lecture:*
From architecture to action: encoding enzymatic responses in polymeric micelles

Roey Amir, *Tel Aviv University*

17:25 - 17:50 *Invited Lecture:*
Adsorption of block-copolymers on the surface of multi-walled carbon nanotubes

Yachin Cohen, *Technion - Israel Institute of Technology*

15:45 - 17:50 Composite Materials and Advanced Applications

Hall F

Chair: **Tal**

15:45 - 16:05 *Invited Lecture:*
Composite materials through vapor phase growth
Tamar Segal-Peretz, *Technion - Israel Institute of Technology*

16:05 - 16:25 *Invited Lecture:*
Thermoplastic composites- current development and future prospects
Olga

16:25 - 16:45 *Invited Lecture:*
A novel method for online monitoring of ambient-temperature aging of prepreg and film adhesive via direct current dielectric analysis
Erez

16:45 - 17:05 Toward bimetallic nanowires: Insights from the co-impregnation of block copolymer films
Roy Shenhar, *The Hebrew University of Jerusalem*

17:05 - 17:20 Insights from biology into the structure–function of composite materials
Israel Kellersztein, *Ben-Gurion University*

17:20 - 17:35 Grafting of polyaniline by a dynamic inverse emulsion polymerization technique onto membranes as an anti-biofouling agent: an innovative approach
Ran Suckeveriene, *Kinneret Academic College on the Sea of Galilee*

17:35 - 17:50 Enhancing magnetization and separation ability of superparamagnetic nanoparticles through magnetic pickering emulsions
Reut Amar Feldbaum, *Agricultural Research Organization (ARO), Volcani Institute*

15:45 - 17:45 Advanced Characterization Methods in Polymers

Hall G

Chair: **Yulia Shitrit**

15:45 - 16:10 *Invited Lecture:*
Tailoring elasticity and relaxation of Alginate-peptide double network hydrogels
Ronit Bitton, *Ben-Gurion University of the Negev*

16:10 - 16:35 *Invited Lecture:*
Characterization of M-N-C carbon aerogels and their activity as oxygen reduction reaction electrocatalysts
Leigh Peles Strahl, *Soreq NRC*

16:35 - 17:00 *Invited Lecture:*
Next-generation ToBRFV diagnostics: chemiluminescence imaging for enhanced sensitivity and on-site assessment
Giorgi Shtenberg, *Agricultural and Biosystems Engineering, Volcani Institute*

17:00 - 17:15 Polymer deconstruction and circularity: insights from NMR methodology
Shira Haber, *Berkeley, USA / Bar Ilan University*

17:15 - 17:30 Probing chain orientation and crystallization kinetics in polylactic acid filaments via low-frequency and polarization-oriented raman spectroscopy
Nadav Yahalom, *Weizmann Institute of Science*

17:30 - 17:45 TBA

15:45 - 17:45 Sustainability in Polymers

Hall H

Dedicated memory to BAZAN Group fallen

Chair: **Rotem Shemesh**, *Carmel Olefins*

15:45 - 16:10 *Invited Lecture:*
Prospects for circular economies in post-consumer plastics
Sabrina Spatari, *Technion - Israel Institute of Technology*

16:10 - 16:35 *Invited Lecture:*
Polymers compostability - standardized methods versus early visual and molecular indications
Yael Laor, *Agricultural Research Organization (ARO), Volcani Institute*

16:35 - 17:00 *Invited Lecture:*
Ulva-derived polymers: a new marine route to bioplastics
Dan Lewitus, *Shenkar Engineering. Design. Art,*

17:00 - 17:15 Untying the knot: a novel, fully recyclable, multipurpose, photocurable adhesive with wide-spectral curing
Natanel Jarach, *The Hebrew University of Jerusalem*

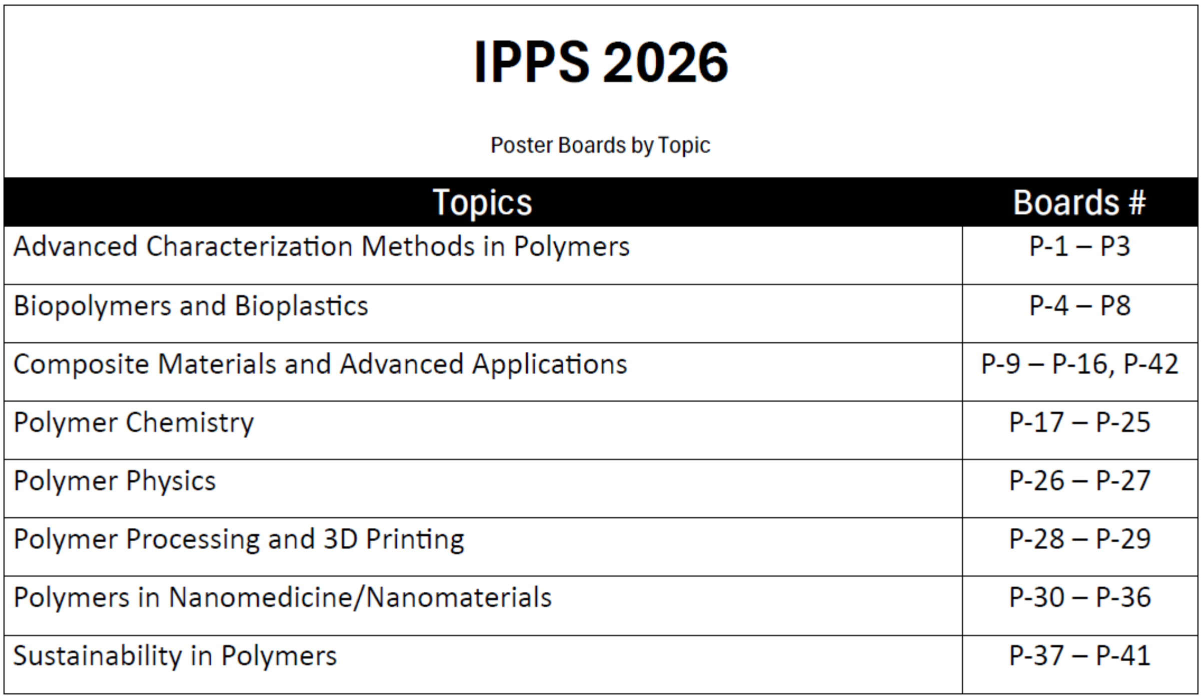
17:15 - 17:30 Nitrogen-rich, polyethyleneimine-based, interpenetrating network porous monoliths: synthesis and application
Dahiana Mayer-Keren, *Technion - Israel Institute of Technology*

17:30 - 17:45 Hierarchical porosity in emulsion-templated block copolymer monoliths: Phase separation, degradation, and hypercrosslinking
Shani Admoni, *Technion - Israel Institute of Technology*

17:50 - 18:00 Closing Remarks and Best Poster/Talk Award

Hall LM

POSTER SESSION



IPPS 2026

Poster Boards by Topic

Topics	Boards #
Advanced Characterization Methods in Polymers	P-1 – P3
Biopolymers and Bioplastics	P-4 – P8
Composite Materials and Advanced Applications	P-9 – P-16, P-42
Polymer Chemistry	P-17 – P-25
Polymer Physics	P-26 – P-27
Polymer Processing and 3D Printing	P-28 – P-29
Polymers in Nanomedicine/Nanomaterials	P-30 – P-36
Sustainability in Polymers	P-37 – P-41

P-1 The new tube: high-resolution cryo-em structure of an engineered protein assembly

Shaked Katzelnick[1], Yiran Yu[2], Racheli Salama[1], Yuval Shoham[1], Dganit Danino[1,2]
[1]*Faculty of Biotechnology and Food Engineering, Technion-Israel Institute of Technology*
[2]*Biotechnology and Food Engineering Program, Guangdong-Technion Israel Institute of Technology*

P-2 Dual stimuli-responsive properties of methylcellulose/carboxymethyl chitosan mixed solutions

Elad Ganot[1], Lea-Hila Mann[2], Lucy Liberman[2]
[1]*Polymer Engineering, Technion*
[2]*Chemical Engineering, Technion*

P-3 Nanoscale Poly(a)morphism of PVDF Thin Films

Lior Snarski[1], Idan Biran[1,2], Sukanta Nandi[3,4], Anastasiya Sedova[1], Haim Weissman[1], Iddo Pinkas[5], Anna Eden-Kossoy[5], Sidney R. Cohen[5], Tomer Lewi[3,4], Lothar Houben[5], Boris Rybtchinski[1]
[1]*Department of Molecular Chemistry and Materials Science, Weizmann Institute of Science*
[2]*VISION – Center for Visualizing Catalytic Processes, Danmarks Tekniske Universitet*
[3]*Faculty of Engineering, Bar-Ilan University*
[4]*Institute of Nanotechnology and Advanced Materials, Bar-Ilan University*
[5]*Department of Chemical Research Support, Weizmann Institute of Science*

P-4 Highly branched clustered dextrin from waxy rice starch: production, structural characterization and its role in slow digestibility

Jingjing Zhao[1,2], Ri Chen[1,2], Harold Corke[1,2], Dganit Danino[1,2]
[1]*Department of Biotechnology and Food Engineering, Israel Institute of Technology*
[2]*Department of Biotechnology and Food Engineering, Guangdong Technion-Israel Institute of Technology*

P-5 Dual composite bioadhesives for wound closure applications: An in vitro and in vivo study

Tom Hanoon[1], Inbar Eshkol-Yogev[1], Efrat Gilboa[2], Yehuda Ullmann[3,4], Aviad Keren[3], Meital Zilberman[1,2]
[1]*Department of Biomedical Engineering, Tel Aviv University*
[2]*Department of Materials Science and Engineering, Tel Aviv University*
[3]*Faculty of Medicine, Technion – Israel Institute of Technology*
[4]*Department of Plastic Surgery and the Burn Unit, Rambam Health Care Campus*

P-6 Novel antibiotic-eluting gelatin-alginate soft tissue adhesives for various wound closing applications

Adaya Shefy-Peleg[1], Meital Zilberman[1]
Department of Biomedical Engineering, Tel Aviv University

P-7 Cellulose fibres enhance the function of hemostatic composite medical sealants

Inbar Levi[1], Efrat Gilboa[2], Inbar Eshkol-Yogev[1], Shir Giladi[2], Meital Zilberman[1,2]
[1]*Department of Biomedical Engineering, Tel-Aviv University*
[2]*Department of Materials Science and Engineering, Tel-Aviv University*

P-8 Double layer and dual drug loaded microneedle patch for comprehensive skin therapy

Gali Cohen[1], Adi Gross[1], Boaz Mizrahi[1]
Faculty of Biotechnology and Food Engineering, Technion - Israel Institute of Technology

P-9 Development and mapping thermally-conductive, electrically-insulating composite coatings for thermal management of electronics

Noam Avtalion[1]
chemical engineering, Ben-Gurion University of the Negev

P-10 Characterization of resins and development of laminates for high temperature composite materials based on phthalonitrile

Liav Keren[1,2], Zvi Deutsch[1], Rakefet Ofek Almog[2]
[1]*Engineering and Development Center, Israel Aerospace Industries*
[2]*Materials Engineering Department, Azrieli College of Engineering Jerusalem*

P-11 Under pressure: Electrical conductivity in compressed hybrid polymer composites

Tal Benlulu[1]
Department of Chemical Engineering, Ben-Gurion University of the Negev

P-12 Silver nanowires organized in periodic arrays

Ofer Burg[1], Roy Shenhar[1]
The Institute of Chemistry and the Harvey M. Krueger Family Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem

P-13 Programmable release of encapsulated microalgae using viscosity-tuned mineral oil carriers

Antolin Jesila Jesu Amalraj[1], Guy Mechrez[1], Mohamed Samara[2]
[1]*Institute for Postharvest and Food Science, Volcani Research Institute, ARO*
[2]*Institute of Soils, Water and Environmental Sciences, Volcani Research Institute, ARO*

P-14 Studying the effect of surface microstructures and micro-climate on microorganisms using biomimetics and thermal imaging

Nofar Hod[1,2,3], Yafit Cohen[3], Iris Yedidia[2], Tali Sayas[2], Guy Lidor[3], Asher Levi[3], Maya Kleiman[2]
[1]*The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem*
[2]*Plant Sciences Institute, Agricultural Research Organization (ARO), Volcani Center*
[3]*Agriculture Engineering Sciences, Agricultural Research Organization (ARO), Volcani Center*

P-15 Micro- and nano-sized Janus Silica Particles for compatibilization of Polyethylene Terephthalate (PET) and Polyethylene (PE) Polymer Blends

Yogapriya Ravi[1], Guy Mechrez[1]
Israel, Volcani institute, ARO

P-16 Hybrid living materials: curcumin/zein pickering emulsions for enhanced m. Brunneum pest control

Michael Brichka[1], Guy Mechrez[1], Dana Ment[2]
[1]*Institute for Postharvest and Food Science, Volcani Institute, ARO*
[2]*Postharvest and Food Science, Hebrew University of Jerusalem*

P-17 Mechanochemistry in epoxy-amine polymers

Raz Azar Buzaglo

P-18 Debondable radiaton-cured adhesives

Rivka Gitt[1,2], Shlomo Magdassi[2], Natanel Jarach[2]
[1]*Materials Engineering, Azrieli College of Engineering*
[2]*The Institute of Chemistry, The Hebrew University of Jerusalem*

P-19 Functionalization of supramolecular polymers using phosphate derivatives

Lior Hamu[1], Nawal Fahoum[1], Roy Shenhar[1]
The Institute of Chemistry, The Hebrew University of Jerusalem

P-20 Multifunctional, multipolymer, macroporous materials through emulsion templating

Lynn Cohen[1], Michael S. Silverstein[1]
Materials science and engineering, Technion

P-21 Rheological behavior of branched supramolecular polymers

Carmel Cohen[1], Ishay Columbus[1], Roy Shenhar[1]
Institute of Chemistry and the Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem

P-22 Covalent grafting of metal chelating ligand to the surface of cotton fabric for reversible binding of copper (II) ions

Karin Shay Gonen[1], Rimi Tanus[1], Limor Mizrahi[1], Hen Shalev[2], Savion Braunstein[3], Ofra Paz Tal[3], Doron Pappo[2], Elizabeth Amir[1]
[1]*Department of Polymer Materials Engineering, Shenkar College*
[2]*Department of Chemistry, Ben-Gurion University of the Negev*
[3]*Department of Chemistry, Nuclear Research Center Negev*

P-23 Ionic-liquid-mediated self-assembly of sulfonated linear-bottlebrush block copolymers

Gilad Sima[1], Inbar-Haya Magid[1], Lucy Liberman[1]
Chemical Engineering, Technion

P-24 Dually selective polymeric membrane for charge-specific and solvent transport using diversely structured copolymers

Layla Namaa[1], Lucy Liberman[1], Charles E.Diesendruck[2]
[1]*The Wolfson Department of Chemical Engineering, Technion Israel Institute of Technology*
[2]*Schulich Faculty of Chemistry, Technion Israel Institute of Technology*

P-25 Mucoadhesive double network hydrogels for sublingual drug delivery

Nagham Rashed[1], Havazelet Bianco-peled[1]
chemical engineering, Technion

P-26 Modeling and validation of film/foam multilayered structures for acoustic applications

Yarin Gindi[1], Naum Naveh[1], Gilad Otorgust[1]
Polymer Materials Engineering, Shenkar College

P-27 Collapse of a single polymer chain: Chain stiffness and attraction range effects

Yanyan Zhu[1], Haim Diamant[2], David Andelman[1]
[1]*School of Physics and Astronomy, Tel Aviv University*
[2]*School of Chemistry, Tel Aviv University*

P-28 Fabrication of flexible and conductive components using digital light projection 3D printing of photochemical resins for soft robotics applications

Shaked Reuveni[1,2], Ouriel Bliah[2], Shlomo Magdassi[2]
[1]*Materials Engineering Department, Azrieli College of Engineering*
[2]*Casali Center of Applied Chemistry, Institute of Chemistry, The Hebrew University of Jerusalem*

P-29 3D printing of edible Pickering emulsions based on pea protein – κ-carrageenan nanoparticles

Galia Hendel[1]
Chemical engineering, Technion, Israel institute of technology

P-30 Smart drug release platform for facile in vitro testing of therapeutic effects

Mai Rose Malovany[1], Roy Shenhar[1], Meital Reches[1], Wade She[2]
[1]*Chemistry, The Institute of Chemistry and the Center for Nanoscience and Nanocharacterization*
[2]*Chemistry, stainable Chemical Science and Technology, Academia Sinica*

P-31 Phase behavior of methylcellulose-based amphiphilic biocompatible block copolymers in solution

Lea Hila Mann[1], Lucy Liberman[1]
Chemical Engineering, Technion

P-32 Hydrogel formulation for sustained release of biomimetic nanoparticles

Oshrat Regev Yehishalom[1]
Nanoscience and Nanotechnology, Technion- Israel Institute of Technology

P-33 Nanoparticles Synthesized from Soy Protein for DNA Delivery and Antifungal Material Delivery

Shai Shefer[1]
The Robert H. Smith Faculty of Agriculture, Hebrew University of Jerusalem

P-34 Development of Zein protein nanoparticle for Targeted Delivery of Genetic Material and Antifungal Compounds

Moran Bakhash[1]
The Robert H. Smith Faculty of Agriculture, Hebrew University of Jerusalem

P-35 Can plastic nanoparticles be detected selectively?

Sara Sason[1,2], Din Zelikovich[1], Daniel Mandler[1]
[1]*Institute of Chemistry, The Hebrew University of Jerusalem*
[2]*Materials Engineering, Azrieli College of Engineering*

P-36 Engineering reverse thermo-responsive (RTR) nanofibers

Tal Abargil[1], Daniel Cohn[2], Mark David Samraj[2], Ing. Harel Cohen[1]
[1]*Materials Engineering, Azrieli College of Engineering*
[2]*Casali Center of Applied Chemistry, Institute of Chemistry, The Hebrew University of Jerusalem*

P-37 Renewable resource polymers for encapsulation of organics for thermal energy storage-release

Nowar Aslan[1], Michael S. Silverstein[1]
Department of Material Science and Engineering, Technion – Israel Institute of Technology

P-38 Effect of UVB irradiation treatment of plastic polymers on biofilm formation of Alcanivorax xenomutans bacteria

Noga Yulis[1,2], Keren Davidov[1]
[1]*Molecular biology, Ariel University*
[2]*Alpha program, Future Scientists Center*

P-39 The effect of UVB irradiation treatment of plastic polymers on the biofilm formation of Alcanivorax balearicus bacteria

Miryam Djuraev[1], Keren Davidov[2]
[1]*Alpha program, Future scientist center*
[2]*Moleculer Biology, Ariel University*

P-40 Incorporation of surface-treated recycled plastic into concrete

Rotem Adam Amar[1], Smadar Kedem Elmachily[2], Semion Zhutovsky[2], Alex Brodsky[3], Naum Naveh[1]
[1]*Department of Polymer Materials Engineering, Shenkar Engineering. Design. Art*
[2]*Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology*
[3]*Department of Civil and Environmental Engineering, Ben-Gurion University of Negev*

P-41 Developing alternative protein from yeast grown on a substrate made from corn plant biomass

Neta Segal[1], Ravit Edelman[1], Yoav David Livney[1]
Faculty of Biotechnology and Food Engineering, Technion Institute of Technology

P-42 Enhancing composite materials performance at elevated temperatures using atomic layer deposition

Eden Elazar[1], Tamar Segal-Peretz[1], Erez Zemel[2], Tamar Gitli[2]
[1]*Chemical Engineering, Technion*
[2]*X, X*

LECTURE ABSTRACTS

Investigation of structure and solubilisation properties of interpolyelectrolyte complexes (IPECs) - effect of hydrophobic modification

Max Darge, Anton Michel-Busch, Matteo Chamchoum, Michelle Buchholz,
Sylvain Prévost, **Michael Gradzielski**[1]
Stranski-Laboratorium für Physikalische und Theoretische Chemie, Institute for Chemistry, Technische Universität Berlin, Germany

Different polymers can form complexes in aqueous solution, provided attractive interactions are present between the polymers, which can be H-bonding or hydrophobic and electrostatic interactions. In particular, oppositely charged polyelectrolytes have a strong tendency to co-assemble, thereby forming interpolyelectrolyte complexes (IPECs), whose structure will depend strongly on the choice of the individual polyelectrolytes, where the chemistry of the monomeric unit, Mw, and the architecture (e.g. linear vs. branched) of the polyelectrolyte play major roles. Typically, IPECs become insoluble upon achieving charge neutralisation in the mixture. This effect can be counterbalanced by employing polyelectrolytes with a second, neutral hydrophilic block, i.e. using a double-hydrophilic block copolymer (DHBC).

In our work, we studied a larger range of such IPECs, with and without the use of DHBC to influence the phase behaviour. In most of the work we used poly(diallyldimethylammonium chloride) (PDADMAC), poly(2-(dimethylamino)ethyl methacrylate) (PDMAEMA) and chitosan as polycation and poly(acrylic acid) (PAA), poly(methacrylic acid) (PMAA) and carboxymethylcellulose (CMC) as polyanion. The complexes formed in aqueous solution were characterised by means of static and dynamic light scattering, small-angle x-ray and neutron scattering (SAXS, SANS), and in some cases by complementary cryo-TEM measurements. The focus was on how the aggregate structure depends on the mixing ratio of the two polyelectrolytes but also on parameters like their Mw, pH or the presence of salt.

In our most recent work, we have functionalised some of the polyelectrolytes by a hydrophobic modification, typically an alkyl chain attached to the backbone and thereby forming a hydrophobically modified polyelectrolyte (HM-PE), and studied how this modification affects the IPEC structure. Such IPECs are interesting, as IPECs in general are advanced as vehicles for delivery of active agents and by incorporating hydrophobic modifications into their core, one can tune the solubilising properties of the IPECs largely. Our structural studies showed that introducing hydrophobic interactions into the IPEC assembly process typically largely affects their structure. The presence of hydrophobic modification often leads to a compaction of the IPEC core, but often also to an interconnection of the aggregates, leading to a soft network structure.

In summary, one finds that hydrophobic modification is an interesting way to tune the structure and properties of IPECs. Combining the concept of HM-PEs and DHBC allows to control phase behaviour and structures over a large range, thereby offering the option to tune soluble IPECs for desired properties and potential applications.

KEYNOTE LECTURE, 10:15-10:55

Unraveling complex spherical packing in block copolymers

Hsin-Lung Chen[1]
Department of Chemical Engineering, National Tsing Hua University, Taiwan

Microphase separation in block copolymers (BCPs) can lead to the formation of spherical micelles at high compositional asymmetry. Like colloidal particles, these micelles exhibit long-range ordering due to repulsive interactions. Understanding the principles that govern their lattice selection is essential for expanding the nanostructural landscape of BCPs and sheds light on scale-invariant crystallization mechanisms from atoms to mesoscale colloids.

To achieve uniform segmental density, BCP micelles deform toward polyhedral shapes corresponding to the Voronoi cells of their packing lattice. The selection of a stable lattice reflects a delicate balance between intermicellar interactions, determined by contact area, and intramicellar free energies associated with chain deformation and interfacial tension, both of which are governed by the geometry of the Voronoi cells. While the body-centered cubic (BCC) lattice is most commonly observed, self-consistent field theory (SCFT) predicts a narrow thermodynamic window for a stable close-packed sphere (CPS) phase. Experimentally confirming the CPS phase and distinguishing whether it favors face-centered cubic (FCC) or hexagonal close-packed (HCP) symmetry remains a challenge. The landscape of spherical micelle packing has grown more complex with the recent discovery of Frank–Kasper (FK) phases in BCPs. Originally found in metal alloys, FK phases comprise tetrahedrally close-packed polyhedra of varying coordination. Although more than 27 FK types are known in metals, only a few, namely, σ, A15, and Laves C14/C15, have been observed in BCP systems. Theoretical studies, especially those using SCFT, continue to probe the mechanisms underlying FK formation, while experimental efforts focus on discovering new molecular features and accessible processing strategies to realize both known and potentially new FK phases in BCPs.

In this presentation, I will discuss new strategies for accessing the FK phases. One effective approach involves the selective incorporation of salts into PEO-containing BCPs, which raises the free energy of the disordered state more than that of the ordered phases. This shift opens a thermodynamic window in which a spherical phase becomes stable at elevated temperatures, even for BCPs with relatively high minority block fractions. Under these conditions, the system transitions from the HEX phase to a spherical phase upon heating, rather than directly to the disordered state, thereby establishing a favorable window for the emergence of FK structures within the accessible spherical phase regime.

I will also show that sugar-based block oligomers (BCOs), consisting of oligosaccharide (Glcn) and solanesol blocks, provide a versatile platform for directing FK phase formation. A stepwise increase in the number of glucose units (n) in the Glcn block induces a sequence of micelle packings: from dodecagonal quasicrystal (DDQC, $n = 1$), to σ phase ($n = 2$), and then to A15 phase ($n = 3$). Notably, the high-temperature σ phase further transforms into Laves C15 and C14 phases upon cooling, thus spanning the full range of FK phases observed in

BCP systems. This pronounced FK-forming ability is attributed to the high-χ/low-N characteristics of the BCOs.

POLYMER CHEMISTRY
parallel session, 11:30

Invited Lecture

Ring opening polymerization by new catalysts: stereoselectivity, activity, and new polymeric microstructures

Moshe Kol[1], Rami Hador[1], Adi Dahav[1], Inbar Kremer-Shitrit[1], Inbar Zaltsman[1], Maayan Vadislavsky[1], Vincenzo Venditto[2]
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[2]*Department of Chemistry and Biology A. Zambelli, University of Salerno, Salerno, Italy*

Poly(lactic acid) (PLA) is a biocompostable polymer derived from annually-renewable resources which is prepared by the catalyzed ring opening polymerization of lactide. PLA of different stereoregularities may be formed by choice of the lactide stereoisomer(s) and choice of the catalyst.

In this presentation we will describe recent findings from our group, concerning catalysis of both lactide polymerization and PLA depolymerization aiming at circular economy of PLA. We will describe exceptionally active / robust [1] / highly stereoselective [2] / living polymerization catalysts that enable the synthesis of highly isotactic PLA from rac-lactide [3], highly syndiotactic PLA from meso-lactide and highly heterotactic PLA from rac-lactide, precise stereo-block copolymers, and stereogradient copolymers featuring desired thermal properties. We will also describe our attempts to recycle / upcycle PLA either directly to the lactide monomer by catalytic depolymerization of PLA, or to alkyl lactates by efficient catalyzed alcoholysis.

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POLYMER CHEMISTRY
parallel session, 11:30

Invited Lecture

Polymeric chiral nanostructured materials

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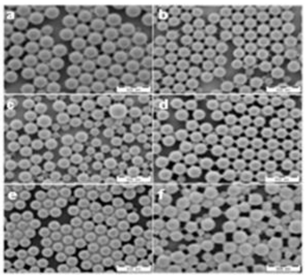
Department of Chemistry and the Institute of Nanotechnology, Bar-Ilan
University, Ramat - Gan, Israel

Polymeric chiral nanomaterials have attracted increasing attention in recent years due to their potential in a wide range of chiral applications. In this lecture, we present selected examples of the synthesis and application of chiral polymeric nanosystems. Particular emphasis is placed on chiral polymer nanoparticles prepared via miniemulsion polymerization of amino acid–based monomers.

Our results demonstrate the use of these polymeric chiral nanomaterials in processes such as chiral crystallization and stereoselective synthesis, highlighting their ability to contribute to the advancement of molecular chirality–based technologies.



Chiral polymeric nanoparticles

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POLYMER CHEMISTRY
parallel session, 11:30

Invited Lecture

Flipping the script the Ben-Gurion way: two novel polymer classes via unconventional metathesis routes

Gabriel Lemcoff[1]
Chemistry, Ben-Gurion University of the Negev, Beer-Sheva, Israel

At Ben-Gurion University, we have a motto: we see things from a different perspective—and that`s what enables us to challenge conventions and push the boundaries of research :-).

In this talk, I will give a general introduction to latent olefin metathesis polymerizations and I`ll present two distinct polymer families, both synthesized via olefin metathesis, but by inverting conventional approaches. In the first example,[1] we flip the typical paradigm by employing latent monomers rather than latent catalysts, exploiting the norbornadiene/quadricyclane photoisomerization system. In the second example,[2] I`ll describe how we finally succeeded—after more than a decade of attempts—in polymerizing jojoba oil to produce high molecular weight ADMET polymers.

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POLYMER CHEMISTRY
parallel session, 11:30

Emulsion-templated hierarchical porosities: Foaming, interpenetrating polymer networks, and hypercrosslinking

Kobi Avarjel[1], Michael S. Silverstein[1]
Materials Engineering, The Technion, Haifa, Israel

Highly macroporous, emulsion-templated polymer monoliths can be synthesized within high internal phase emulsions (HIPEs, 74% internal phase). While free radical polymerization
(FRP) is the most common synthesis, step-growth polymerization (SGP) provides additional versatility for material design. Interpenetrating polymer networks (IPNs) consist of two distinct, crosslinked polymer networks that are interlaced without covalent bonding, while semi-IPNs include one crosslinked and one linear polymer. These materials can be prepared through mutually exclusive simultaneous polymerizations or sequential polymerizations. In this work, hierarchically porous emulsion-templated IPNs were synthesized through simultaneous FRP (styrenics) and SGP (poly(urethane urea amide)s (PUUAs) based on diisocyanates, castor oil, carboxylic acids, and water. Large-scale macroporosity was generated via foaming and microporosity was generated via Friedel–Crafts alkylation hypercrosslinking.

The emulsion-templated monoliths were characterized using spectroscopy, thermal analysis, electron microscopy, and nitrogen adsorption porosimetry.
The monoliths exhibited low densities and open-cell structures (except the PUUA reference, which showed a closed-cell-like structure). Increasing the PUUA content enhanced the porosity due to foaming (release of CO2 from isocyanate reactions). Thermal analysis revealed that the monoliths based on an aliphatic diisocyanate exhibited two distinct tan δ peaks, indicating phase separation. On the other hand, the monoliths based on aromatic diisocyanates displayed two merged tan δ peaks, suggesting more extensive macromolecular entanglements. Hypercrosslinking was only able to generate microporosity in materials with 75% or more styrenic polymers. This demonstrates that foaming was able to generate hierarchically porous structures with millimeter-scale pores at high PUUA contents while hypercrosslinking was able to generate hierarchically porous structures with pores of less than 2 nm at high styrenic polymer contents.

POLYMER CHEMISTRY
parallel session, 11:30

Vapor-synthesized polyamide with angstrom-level precision for desalination membranes

Ruoke Cai[1], Brian C. Welch[2], Jay P. Singh[2], Jeremiah W. Woodcock[3], Kirti Sankhala[4], Guy Ramon[5], Christopher M. Stafford[6], Viatcheslav Freger[2], Tamar Segal-Peretz[2]
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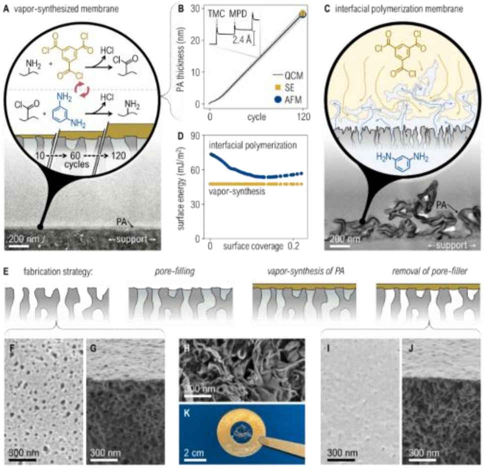
[3]*Material Science and Engineering, National Institute of Standards and Technology, United State*
[4]*Center for Emerging Technologies for Sustainable Development, Indian Institute of Technology Jodhpur, India*
[5]*Civil and Environmental Engineering, Technion – Israel Institute of Technology, Israel*
[6]*Materials Science and Engineering, National Institute of Standards and Technology, United State*

Polyamide desalination membranes are critical for producing clean water, but imprecise and inhomogeneous selective layers made from conventional solvent-based methods fail to unlock their full potential. Here, we demonstrate a vapor-phase, layer-by-layer polymerization approach to synthesize ultrathin, crosslinked polyamide films with molecular-level precision. This solvent-free process enables controlled polymer growth with Angstrom-scale resolution, yielding exceptionally smooth, dense, and homogeneous films. Remarkably, membranes having thickness of 12 nm exhibit twice the NaCl selectivity of commercial desalination membranes, while salt and boron permeabilities are reduced by two orders of magnitude. This study establishes vapor-phase polymerization as a powerful route for designing next-generation polyamide materials and provides fundamental insight for probing and optimizing molecular transport in membranes.



POLYMER CHEMISTRY
parallel session, 11:30

Chemical grafting of polymers as a tool for fabrication of functional materials

Elizabeth Amir[1]
Polymer Materials Engineering, Shankar, Israel

Surface grafting of polymer substrates by chemically attaching small molecules allows tailoring surface characteristics and can lead to improved biocompatibility, hydrophilicity/hydrophobicity, or creat antibacterial surfaces. The talk will describe design strategies and methods for surface modification of cellulose- and collagen-based substrates such as cotton fabrics and fish leather, specifically seeking chemical processes which are modular, scalable and would preserve the intrinsic properties of the substrate, while introducing durable and functional coatings. The examples will include preparation and novel applications of cotton fabrics and fish leather with controlled hydrophobicity, oil-water separation, antibacterial, and electro-conductive properties. In addition, we developed a two-step method for the covalent grafting of metal chelating ligand onto the surface of cotton fabric for efficient and reversible removal of heavy metals from water sources. The second part of the presentation will show how byproducts from food industry such as fish skin gelatin can be used as high-value materials for the fabrication of crosslinked hydrogels and coatings for encapsulation and controlled release of active agents. The most important learning that we gain from the results of our research is that modern chemical reactions allow facile synthesis of functionalized biopolymers with well-controlled molecular architectures.

Invited Lecture

Living delivery system for the treatment of skin infections

Boaz Mizrahi[1]
Faculty of Biotechnology and Food Engineering, Technion, Haifa, Israel

Living biomaterials are hybrid systems that integrate live organisms, such as bacteria or mammalian cells, with traditional biomaterials. This combination offers the best of both worlds: the biological activity and responsiveness of living systems, together with the structural stability, versatility, and tunability of engineered materials. These living constructs are capable of sensing their environment, producing and releasing therapeutic biomolecules, and maintaining functionality even in harsh physiological conditions. To date, most clinically available bacterial formulations are restricted to a narrow range of genera and are typically limited to gastrointestinal indications. In this lecture, I will introduce the broader concept of "living materials" and showcase recent advances that expand their potential into topical, transdermal, and implantable therapeutic platforms. I will present examples from our laboratory, including thermoresponsive hydrogels, particulate systems, and microneedle-based platforms, all designed to host and support living bacteria capable of continuously producing beneficial agents in situ. These systems function as miniaturized biological "factories", offering self-sustained therapeutic delivery directly at the site of need. By merging microbiology, materials science, and drug delivery, these platforms represent a novel and powerful class of biomedical technologies.

POLYMERS IN MEDICINE AND NANOTECHNOLOGY
parallel session, 11:30

Invited Lecture

Biocompatible narrow size nanohydrogels for drug delivery

Gerardo Byk[1]
Department of Chemistry, Bar Ilan University, Israel

We have designed and synthesized new series of monodispersed nanometric particles with high biocompatibility. The particles are obtained by radical polymerization of thermo-responsive mixtures of monomers. The biocompatibility of the particles allows their application to a variety of biological systems such as cell sensing, drug delivery and gene delivery that will be presented.

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POLYMERS IN MEDICINE AND NANOTECHNOLOGY
parallel session, 11:30

Interactions of amphiphilic interpolyelectrolyte complexes with liposome membranes, studied by on-the-grid processing cryo-transmission electron microscopy

Sapir Rappoport[1], Michael Gradzielski[2], Yeshayahu Talmon[1]
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Nanotechnology Institute (RBNI), Technion – Israel Institute of Technology,
Haifa, 3200003, Israel
[2]*Stranski-Laboratorium für Physikalische und Theoretische Chemie, Institut*
für Chemie, Technische Universität Berlin, Berlin, Germany

Amphiphilic interpolyelectrolyte complexes (IPECs) have attracted a significant interest in colloid science and nanomedicine as drug delivery carriers. Compared to surfactant micelles, IPECs offer greater stability while retaining responsiveness to external stimuli such as pH and ionic strength. Drugs are typically encapsulated within their hydrophobic core and retained through electrostatic forces or other non-covalent interactions. An important aspect of IPEC-based drug delivery is the interaction with lipid membranes, which governs the efficient transport of therapeutic agents into cells. Understanding these interactions requires not only characterization of the final structures but also the intermediate structures and the dynamics through which they evolve.

To study these dynamics, we introduce a novel on-the-grid processing approach for cryogenic transmission electron microscopy (cryo-TEM). In this approach, IPECs and liposomes are mixed directly on a grid, blotted, and rapidly vitrified after defined time intervals. This enables imaging intermediate nanostructures with a time resolution of about 2 seconds. Using this method, we examine interactions between poly(diallyldimethylammonium chloride) (PDADMAC) and poly(acrylic acid) sodium salt (NaPA) complexes with dioleoylphosphatidylcholine (DOPC) vesicles as a model lipid membrane system. In that system, we study how different hydrophobic modifications of NaPA influence aggregation and membrane binding, as well as how pH conditions modulate these interactions. These studies demonstrate the principles of IPEC–membrane interactions, and highlight parameters essential for designing responsive nanocarriers. Figure 1 shows the interaction between PDADMAC/NaPA complexes and DOPC vesicles at pH of 9. Initially, the two types of aggregates coexist, after which the vesicles surround the IPECs, eventually leading to the formation of multilamellar vesicles.

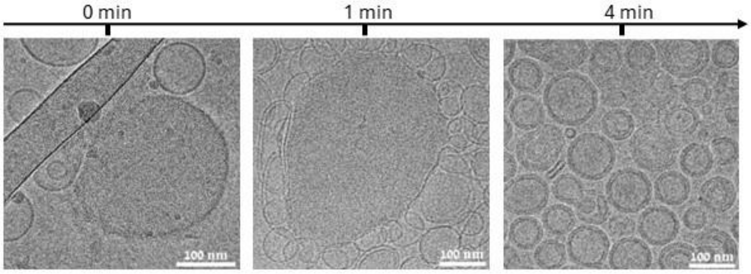

Figure 1. Nanostructural intermediates of PDADMAC/NaPAA complexes and DOPC vesicles imaged at different time points after mixing.

POLYMERS IN MEDICINE AND NANOTECHNOLOGY
parallel session, 11:30

Developing optical implantable matrices for clinical monitoring

Noemie Chekroune[1], Zvi Yaari[1]
Faculty of Medicine, The School of pharmacy, Jerusalem, The Hebrew University

Single-walled carbon nanotubes (SWCNTs) exhibit distinct near-infrared photoluminescence with exceptional photostability, deep tissue penetration, and minimal autofluorescence, positioning them as promising candidates for long-term biosensing. Their emission is highly sensitive to the surrounding environment—redox interactions modulate intensity, while dielectric changes induce solvatochromic wavelength shifts—allowing label-free optical detection of small molecules and biomarkers. To translate this potential into biomedical applications, SWCNTs must be embedded within biocompatible polymer matrices that preserve fluorescence, prevent aggregation, and permit analyte diffusion. Hydrogels, as hydrophilic and tunable polymer networks, are ideal for this role due to their structural similarity to biological tissues.

In this study, hydrogel formulations were engineered to investigate how mechanical and structural properties influence the fluorescence and stability of embedded SWCNTs. Comprehensive characterization included swelling ratio, rheology, and compression testing to evaluate viscoelastic behavior, complemented by near-infrared fluorescence spectroscopy to assess optical performance and analyte sensitivity. Fluorescence stability and nanotube retention were monitored over time to evaluate matrix–nanotube compatibility.

All hydrogel systems successfully incorporated SWCNTs while maintaining stable, responsive emission. Exposure to small analytes induced detectable shifts in fluorescence intensity or wavelength, confirming preserved sensing capability. Distinct differences in swelling, stiffness, and viscoelastic profiles among formulations revealed clear correlations between mechanical characteristics and optical performance. These findings highlight the ability to fine-tune hydrogel composition and crosslinking to optimize SWCNT signal stability, analyte accessibility, and mechanical integrity.

This work establishes a framework for designing multifunctional polymeric hydrogels tailored for SWCNT-based biosensing, bridging polymer science and nanophotonics toward next-generation implantable sensing platforms.

POLYMERS IN MEDICINE AND NANOTECHNOLOGY
parallel session, 11:30

3D printing of personalized catheters with smart pH-responsive coating for improved functionality, cytocompatibility, and anti-bacterial characteristics

Eid Nassar-Marjiya[1]
The Laboratory for Advanced Functional/Medicinal Polymers & Smart Drug Delivery, Technologies, The Wolfson Faculty of Chemical Engineering, Technion-Israel Institute of Technology, Israel

Hydrocephalus is a common brain disorders and remains as challenging condition throughout life. The available treatment for hydrocephalus includes surgically implanting catheters for shunting cerebrospinal fluid (CSF). While this method considered as gold standard treatment, yet catheters face many issues such as blockage, mechanical malfunctions, host-immune response and microbial infection. To overcome these challenges, herein we propose using 3D printing technology to develop the next generation catheters with enhanced functionality and liquid flowability. we offer a personally designed catheter for each patient that is specially designed and printed based on its personal imaging data. For the first time, we report a helically shaped flexible catheters, that are printed with digital light processing (DLP) technology using commercial KeySplint soft resin. The enhanced catheters are fully customizable, where the diameter, the number and placement of the drainage holes are tailored according to each patient case. To overcome the catheter's blockage, a pH-responsive smart surface chemistry was introduced with two different approaches (plasma treatment and resin mixing). In vitro stability study proved that 3D printed KeySplint remains stable at physiological conditions for at least 135 days. Additionally, both plasma-coated and 5% CB-OH mixed 3D printed catheters prevented biofilm formation for 24, 48 and 72 hours compared to KeySplint alone. Moreover, the CB-OH coated 3D-printed helical catheters showed a 37-folds reduction in particle deposition per unit volume compared to conventionally designed KeySplint 3D-printed linear catheters. Thus, the findings indicated that the proposed fully tailored surface-functionalized 3D-printed catheters could ofer a potential alternative/solution for medical implants and vascular grafts for hydrocephalus treatment.

Invited Lecture

Algal protein-based 3D-printed fish-analogs as a new approach for sustainable seafood

Yoav D. Livney[1], Samaa Alasibi[1], Meital Kazir[1], Álvaro Israel[2]
[1]*Biotechnology & Food Engineering, Technion IIT, Haifa, Israel*
[2]*Israel Oceanographic and Limnological Research, The National Institute of Oceanography, Haifa, Israel*

Rising global demand for animal-products exceeds human-population growth. This unsustainable trend causes harmful ecological effects. Overfishing causes extinction of aquatic animals and a dangerous biodiversity loss harming aquatic ecosystems. Hence, replacing animal-based food, particularly beef and fish, with sustainable alternatives is an urgent vital global mission. Analogs of animal-based products include plant-based, tissue-culture-based and fermentation-based products. Fish analogs have mainly been based on plant-protein, fungi, tissue-culture, but to our knowledge, fish analogs made of algae, particularly macroalgae, as the major component and protein-source have not been reported. 3D-food-printing is a fast-developing technology, enabling formation of complex three-dimensional structures with various heterogeneous topologies and tailorable compositions. Herein, we report the co-extraction of proteins and polysaccharides from the red marine-macroalgae Gracilaria cornea, and using the extract in injection-based 3D-printing to form prototypes of salmon-fillet. Two bioinks were used: a red bioink dyed with microalgal-astaxanthin, for the muscle tissue, and a white bioink dyed with CaCO3, for the 'connective' tissue. Algal proteins have excellent nutritional amino-acid composition, and the co-extraction with agar facilitates 3D-printing thanks to its pseudoplastic and gelling properties. This study highlights macroalgae as an exciting natural raw-material for fish analogs towards sustainable seafood production, thereby decreasing harm to ocean fisheries.

Reference

Samaa Alasibi, Meital Kazir, Álvaro Israel, Yoav D. Livney, Algal protein-based 3D-printed fish-analogs as a new approach for sustainable seafood (Short Communication), Current Research in Food Science, Volume 9, (2024), 100905.

https://doi.org/10.1016/j.crfs.2024.100905

Invited Lecture

Elucidating the role of root surface physical properties in root-environment interactions using biomimetics

Maya Kleiman[1], Tali Sayas[1], Pallavi Kumari[1], Michal Amrani[1,2], Sigal Brown-Miyara[3], Patricia Bucki[3]
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[2]*The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel*
[3]*Institute of Plant Protection, Agricultural Research Organization (Volcani Center), Israel*

This research demonstrates the use of bio-based polymers to fabricate synthetic root mimics, enabling the isolation of physical and mechanical cues in complex plant-environment interactions. While biological systems utilize evolutionarily optimized structural solutions, their inherent chemical complexity often masks the role of surface physics. By employing a biomimetic approach, we mimic the plant root surface using natural polysaccharides to decouple structural and mechanical effects from biological signaling.

We utilize a multicomponent polymer matrix composed of polydimethylsiiloxne (PDMS) and other biopolymers such as: carboxymethyl cellulose (CMC), cellulose nanofibers (CNF), xyloglucan, and pectin. PDMS is enabling us the replicate of 3D microstructural topography of the root. The other biopolymers allow us to adjust material mechanical properties to study how surface stiffness and porosity affect the penetration mechanisms of parasitic nematodes. Additionally, the inclusion of specific cell-wall polysaccharides allows the mimic to serve as a substrate for Cell Wall Degrading Enzymes (CWDE), providing a reactive interface that simulates natural root penetration.

This platform not only aids in elucidating fundamental plant-pathogen mechanobiology but also serves as the basis for sustainable agricultural materials. We are currently developing a "pesticide-free pesticide" using these polysaccharide-based architectures to create physical traps that lure and capture nematodes through biomimicry, offering a biodegradable and non-toxic alternative to traditional chemical control.

BIOPOLYMERS AND BIOPLASTICS
parallel session, 11:30

Stretchability and melt strength enhancement of biodegradable polymer blends for packaging solutions

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Polymer Materials Engineering Department, Shenkar - Engineering. Design. Art., Ramat-gan, Israel

Biodegradable polymers, while environmentally advantageous, often lack the stretchability required for demanding applications such as flexible films and woven fabrics. This research aimed to overcome this limitation by enhancing the stretchability of a biodegradable blend of poly(butylene adipate-co-terephthalate) (PBAT) and poly(lactic acid) (PLA) through reactive extrusion. The core objective was to develop a PBAT-rich blend with high melt strength and elasticity, which is predisposed to orientation during film manufacturing.

Compatibilization was achieved through reactive extrusion by incorporating various chain extenders (epoxy, oxazoline, and anhydride-based) in the presence of radical initiators (dicumyl peroxide (DCP) and 2,5-Dimethyl-2,5-di(tert-butylperoxy) hexane). The resulting interfacial reactions led to the formation of an entangled network structure.

The characterization of the reactive blends revealed significant improvements. Rheological analysis of the radical initiated blend showed an increase in shear and complex viscosity by up to 93% and 85%, respectively. The improved miscibility between the PLA and PBAT phases was confirmed by a reduction of 9∘C in ΔTg, along with a finer morphological dispersion observed via microscopy. This enhanced interfacial adhesion and higher molecular weight led to superior mechanical properties. The addition of 0.1% wt. DCP resulted in a remarkable 200% increase in elongation at break and a 44% improvement in tensile strength. The orientation tendency of the compatibilized blend further improved the tensile strength by 34% and achieved a threefold enhancement after machine direction orientation (MDO). These findings demonstrate that a compatibilization-driven approach via reactive extrusion can effectively produce high-performance, stretchable, and biodegradable films suitable for various applications.

BIOPOLYMERS AND BIOPLASTICS
parallel session, 11:30

Mussel-inspired chitosan hybrid films for multifunctional wet bioadhesion

Noam Rachel Avruch[1], Yelena Albert[1], Galit Fichman[1]
Biochemistry, Food Science and Nutrition, The Hebrew University of Jerusalem, Rehovot, Israel

Bioadhesives have emerged as promising materials in various biomedical and biotechnological applications. However, the functionalities of existing polymer-based bioadhesives remain limited due to weak wet adhesion or limited mechanical compliance. These limitations motivate the design of next-generation materials that integrate strong interfacial bonding, elasticity, and functional performance in physiological environments. Here, we propose a novel bioadhesive platform by pairing mussel-inspired catechol chemistry on chitosan (Cat-Chit) with Fmoc-DOPA, a self-assembling amino acid (SAAA), combining catechol-driven adhesion with supramolecular order to form a multifunctional wet-adhesive material. Specifically, the resulting Cat-Chit/Fmoc-DOPA hybrids form freestanding, homogeneous films that adhere strongly to soft tissues yet remain flexible. Comprehensive mechanical, swelling, thermal, and spectroscopic analyses reveal synergistic gains in elongation, elasticity, and strength relative to single-component systems. Under wet conditions, lap-shear and peel tests confirm robust interfacial bonding to hydrated porcine buccal tissue and chicken heart. The films behave as elastomers, transforming an otherwise brittle biopolymer matrix into a compliant composite that conforms to moving tissues, an important attribute for dynamic physiological interfaces. The films also exhibit antibacterial and antioxidant activities. Collectively, these attributes position the films as practical platforms with potential applications in mucoadhesive patches and wound dressings, offering antioxidant and antibacterial functionality.

Atomic layer procesess for UV-stable polymers: synergistic effects of infiltration and deposition of ZnO

Gil Menasherov[1], Nidaa Shrara Herzallh[1], Tamar Segal-Peretz[1]
Chemical Engineering, Technion- Israel Institute of Technology, Haifa, Israel

Ultraviolet (UV) radiation is the major cause for polymer degradation in outdoor environments, accelerating mechanical failure and color change, leading to plastic waste accumulation. Effective UV-protective strategies that preserve polymer functionality are therefore critical for extending material longevity in UV-intense environments. Here, we present a synergistic approach combining vapor phase infiltration (VPI) and atomic layer deposition (ALD) to engineer nanoscale zinc oxide (ZnO) coatings on poly(lactic acid) (PLA), a UV-sensitive polymer. Individually, ALD and VPI offer minimal enhancement in UV stability; however, their sequential application enables the formation of conformal, polycrystalline ZnO films that dramatically improve UV resistance in both 3D-printed structures and thin-film PLA models. In situ microgravimetry and cross-sectional electron microscopy reveal that VPI introduces ZnO nucleation sites within and atop the polymer matrix, promoting a 10-fold increase in ZnO growth per ALD cycle. The resulting ZnO–PLA hybrids absorb over 90% of incident UV-C radiation while maintaining high optical transparency in the visible range. This low-temperature, scalable process provides a promising platform for the development of transparent, durable UV-barrier coatings on polymers for use in environmentally demanding applications.

POLYMER PROCESSING AND 3D PRINTING
parallel session, 11:30

Invited Lecture

UV crosslinking of polyethylene: from chemistry to packaging performance

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Performance of polyethylene (PE) films in demanding packaging applications is often limited by insufficient thermal stability, creep resistance, and mechanical robustness at elevated temperatures, arising from the high chain mobility of polyethylene as a thermoplastic polymer. Enhancing performance while maintaining processability remains a significant challenge.

This presentation investigates UV-induced crosslinking as a controlled approach to modifying the polyethylene network and improving functional properties. A proprietary photoinitiator system enables efficient radical generation under UV irradiation, leading to covalent interchain bond formation. The process can be implemented inline or offline using conventional extrusion and converting equipment.

Structure–property relationships are evaluated through systematic variation of photoinitiator concentration and UV dose. Mechanical and thermal testing demonstrates that UV-crosslinked PE films exhibit substantially reduced creep deformation, improved puncture and tear resistance, and enhanced mechanical stability at elevated temperatures (120–135 °C). Tensile property retention and seal integrity under high-temperature conditions are significantly improved compared to non-crosslinked films.

These results demonstrate that UV-induced crosslinking enables precise tuning of polyethylene performance through controlled network architecture, supporting the development of high-performance mono-material PE films for advanced packaging applications.

POLYMER PROCESSING AND 3D PRINTING
parallel session, 11:30

Invited Lecture

Nemo nanomaterials - turning nanotech into industrial advantage

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The integration of nanomaterials into polymer matrices offers significant potential to enhance material properties, yet scaling from laboratory research to industrial production remains challenging. This work presents Nemo Nanomaterials scalable approach using NemoBLEND™ a masterbatch based on Single Walled Carbon Nanotubes (SWCNTs) engineered for seamless incorporation into existing extrusion and injection molding processes.

Through advanced formulation and processing technologies, NemoBLEND™ achieves uniform dispersion and interfacial compatibility within thermoplastic polymers, enabling controlled electrical conductivity and lightweight carbon-based EMI shielding. The masterbatches provide flexible volume resistivity ranges, easy processability, and compatibility with colored masterbatches, supporting long production runs without die buildup.

This scalable platform bridges nanotechnology and industrial application, offering promising solutions for packaging, automotive, and advanced engineering plastics.

POLYMER PROCESSING AND 3D PRINTING
parallel session, 11:30

Invited Lecture

Novel polyolefin vitrimer chemistry with improved melt processability: can we spare the crosslinker?

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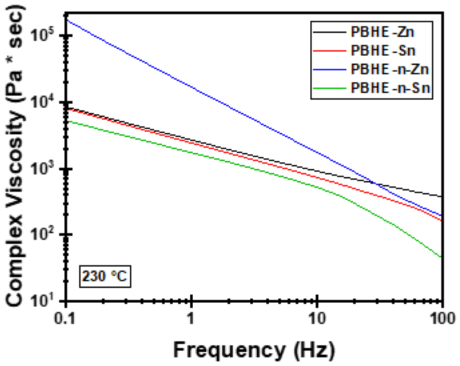
The viscosity of epoxy-based β-hydroxy ester vitrimers (PBHE) can be controlled by the stoichiometry and the choice of catalyst, aside the temperature and shear rate for melt processable materials. Previous work showed that poly(ethylene-co-glycidyl methacrylate) and an anhydride react in the molten state resulting in a polyolefin/polyester vitrimer with relatively low T_g ad T_v values, allowing their incorporation into thermoplastic blends for various applications.

Currently, epoxy vitrimers are primarily based on transesterification reactions, resulting in relatively high viscosities. Lower viscosities should enable wider application of vitrimers in melt processable systems.

This study investigates transetherification through catalyzed ring opening homo-polymerization of epoxy. Characterization includes FTIR, swelling tests, DMA, TGA, rheology and stress relaxation. The viscosities of the transetherified epoxies are indeed lower compared to classic transesterified-based epoxy vitrimers, at similar cross-link densities. Transetherification is achieved within typical polyolefin processing conditions (up to 230ºC). These results may offer an alternative route to epoxy vitrimers, eliminating the need for cross-linkers.



Rheology analysis of PBHE vitrimer with Zn-based or Sn-based catalyst, with (PBHE-Zn and PBHE-Sn) and without anhydride (PBHE-n-Zn and PBHE-n-Sn).

3D printed omniphobic slippery liquid infused porous surfaces

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Omniphobicity is attracting growing interest due to its ability to enable dynamic liquid mobility and impart multifunctional properties, including self-cleaning, antifouling, and anti-icing. Slippery Liquid-Infused Porous Surfaces (SLIPS) are a promising approach for achieving omniphobicity, as they can repel liquids across a wide range of surface tensions. However, their integration into complex three-dimensional (3D) architectures has remained challenging.

In this study, we report the fabrication of omniphobic 3D-printed SLIPS using digital light processing (DLP). The printed structures incorporate internal reservoirs connected to the surface through microchannel networks, enabling retention and continuous replenishment of a fluorinated lubricant. A new photo-curable ink, composed of acrylate monomers and silica nanoparticles, was developed to fabricate high-resolution porous architectures. The printed structures were subsequently linked with a fluorinated precursor to ensure compatibility with the infused lubricant.

The resulting printed SLIPS exhibited very low sliding angles for liquids of varying surface tensions, including 3.5° ± 0.5° for water and 2.0° ± 0.4° for n-hexane. Furthermore, complex 3D SLIPS geometries were demonstrated, highlighting the versatility of this approach. This approach enables the fabrication of functional omniphobic surfaces that cannot be achieved using conventional methods, and can be extended to materials with tailored mechanical properties for advanced functional devices, including soft robotics and medical devices.

POLYMER PROCESSING AND 3D PRINTING
parallel session, 11:30

Additive manufacturing of flexible strain sensors based on polymer nanocomposites

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Chemical Engineering, The Ben gurion University of the Negev, Beere Sheva, Israel

Flexible sensors are lightweight and employed in various applications such as wearable devices, soft robotics, and biomedicine. Flexible strain sensors are the main elements in soft intelligent devices that respond to mechanical deformation through changes in their electrical properties. In this study, we produce such electrical conductivity-based sensors via additive manufacturing (AM), specifically digital light processing, allowing accurate fabrication with minimum waste and avoiding the use of expensive metals. We 3D-print polymeric nanocomposites loaded with carbon nanotubes (CNT), known for their high electrical conductivity. The electrical percolation threshold of the printed composite was measured at 0.15 wt% CNT, which was selected for further experimentation. At this concentration, the electrical resistivity was measured concomitantly with the application of a range of compressive strains, resulting in a relatively low sensitivity (gauge factor (GF) 1.4). To enhance the sensitivity, we introduce graphene nanoplatelets into the CNT-based composite, forming a hybrid composite system that yields an outstanding response to the applied strain, achieving a GF of 50. In addition, the 3D-printed composite demonstrated excellent mechanical recovery, restoring its initial shape after the application of cyclic compressive strain. The developed 3D-printed hybrid composite presented a highly sensitive, lightweight, and scalable solution for flexible strain sensing with potential applications in various fields.

Life cycle assessment of upcycling polyolefin waste to sustainable aviation fuel via pyrolysis

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Plastic production has grown twentyfold since 1950, yet recycling remains below 10%, leaving 150 million tonnes of waste littering our oceans due to improper management on land, an amount expected to be tripled by 2030. Polyolefins account for approximately 50% of the annual total plastic production and produce low-value products from conventional recycling methods. Pyrolysis, a thermochemical recycling technology, is a promising alternative that converts polymer chains into smaller hydrocarbon compounds such as oils, waxes, solids, and condensable and non-condensable gases in the absence of oxygen under high temperatures (500°C). Because polyolefin pyrolysis yields hydrocarbon compounds, these products could be ideal building blocks for upgrading into fuels and chemicals, advancing a circular economy. Out of the pyrolysis products, specifically, pyrolysis oils could be upgraded to be used as sustainable aviation fuel (SAF). Life cycle assessment (LCA) is a key analytical tool for evaluating sustainable emerging technologies. While SAF produced from renewable biomass is a promising decarbonization route, under LCA evaluation, it often comes with notable tradeoffs of acidification, eutrophication, land use, and water impacts. Supporting bio-based SAF with SAF produced from plastic waste could offer the dual benefit of diverting plastics from the natural environment and mitigating these environmental impacts. This research evaluates the environmental performance of upcycling polylefin waste into SAF via pyrolysis and catalytic upgrading using LCA, with results showing a reduction in greenhouse gas emissions of 13% to 36% compared to petroleum jet fuel, depending on the integration of renewable and low-carbon technologies. The results could support the identification of promising waste-to-fuel valorization pathways aligned with low-carbon policy objectives.

POLYMER PHYSICS
parallel session, 15:45

Invited Lecture

Two-state theory of polymer glass transition - recent developments and successes

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Understanding glass transition is crucial for many applications of polymers – membranes, packaging, pharmaceutical, coatings, etc. In one of the most famous and tragic examples, the US Space Shuttle Challenger exploded because the rubber O-rings experienced a glass transition during the launch in cold weather and could no longer seal the hot fuel. Although glass transition has been studied theoretically and experimentally for almost a century, there is no comprehensive theory that describes its multiple manifestations – the sharp increase in viscosity or relaxation time upon cooling; the stretched-exponential relaxations of stress, enthalpy, and density; the slow change of physical processes upon material aging; the dependence of the glass transition temperature on polymer molecular weight; the dependence of the glass transition temperature on the polymer film thickness, etc. I will present our recent work on the development of a new type of a two-state theory of glass transition – the two-state, two (time)scale theory or TS2. It is shown that TS2 can successfully describe the relaxation time dependence on the temperature, as well as the non-exponential volume and enthalpy relaxations. Furthermore, we show that when combined with an appropriate equation of state (such as Sanchez-Lacombe), TS2 can describe the universal "Boyer rules" relating the thermal expansion coefficients of polymers above and below the glass transition. Finally, I discuss an interesting "universality" emerging within the TS2 model, where the relaxation times for multiple polymers can be collapsed onto a single master curve with only two material-specific parameters ("material time" and "material energy"). This work was done in collaboration with Alessio Zaccone (University of Milan, Italy), Oleg Gendelman (Technion, Israel), and Riccardo Casalini (Naval Research Laboratory, USA).

POLYMER PHYSICS
parallel session, 15:45

Invited Lecture

Emulsion templating: DIY versatility for the creative design of porous polymers

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Porous polymers are of interest for a wide variety of applications including absorption, adsorption, tissue engineering, membranes, controlled release, reaction supports, and shape memory foams. Emulsion templating can be used to generate high-porosity, macroporous polymer monoliths with highly interconnected, micrometer-scale porous structures through polymerization in the external, continuous phase followed by removal of the internal, dispersed phase. Emulsion templating possesses, on one hand, the benefit of being seemly simple. This simplicity, however, belies its inherent versatility and considerable parameter space that enables creative design of innovative new materials in terms of their macromolecular structures, their porous structures, and their properties.

Approaching emulsion templating with a specific structure or application in mind can enable a do-it-yourself (DIY) outlook to imaginatively selecting the most appropriate emulsion type, stabilization strategy, polymerization mechanism, crosslinking strategy, and post-synthesis modification. The research and development of emulsion-templated polymers has been blossoming, as reflected not only in the number of articles published, but also in the number of novel porous polymer materials synthesized and in the number of heretofore unexplored applications investigated. It is the hidden complexity of emulsion templating that enables a continuous stream of pioneering works stemming from breakthrough insights in connected and contiguous scientific fields. This appraisal, highlighting emulsion templating strategies with specific examples, will serve as a guide for those involved in developing innovative polymers with unique macromolecular and porous structures that engender exceptional properties. Contemplating the future directions of emulsion templating, given the robust nature of its established foundation, suggests that innovative research and development will continue to flourish.

POLYMER PHYSICS
parallel session, 15:45

Invited Lecture

Effects of cross-linking on spatial organization and dynamics of confined associating polymers

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Physics, Bar-Ilan University, Ramat-Gan, Israel

We performed Langevin dynamics simulations of two confined polymers containing strongly associating stickers. We investigated the reorganization time scales of polymers cross-linked by sticker aggregates (clusters) and found that strong specific interactions lead to the formation of a polymer gel, with cluster reorganization times growing exponentially with interaction strength. We observed that increasing the strength of specific interactions between stickers promotes segregation and reduces the overlap between the polymers. The relevance of our results to the formation and maintenance of chromatin territories in eukaryotic nuclei is discussed.

POLYMER PHYSICS
parallel session, 15:45

Invited Lecture

From architecture to action: encoding enzymatic responses in polymeric micelles

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Biological soft matter achieves adaptability by coupling molecular stucutre and function. Replicating this behavior in synthetic polymer assemblies remains challenging, particularly for enzyme-responsive micelles, where high kinetic stability often suppresses degradability. In this lecture, I will demonstrate how the micelle–unimer exchange dynamics serve as the key physical parameter governing enzymatic accessibility in polymeric micelles.

We developed a modular platform of dendritic amphiphiles capable of in situ architectural transition from triblock to diblock copolymers, enabling precise and independent control over molecular weight, architecture, and hydrophobicity without altering thermodynamic assembly conditions. Using FRET-based micellar mixing assays, we directly quantified unimer exchange kinetics across a systematic series of amphiphiles. Increasing hydrophobicity and triblock architecture produces kinetically trapped micelles with extremely slow chain exchange, whereas architectural splitting dramatically accelerates exchange dynamics. Independent enzymatic degradation studies reveal a striking quantitative correlation between exchange rates and hydrolysis kinetics, providing direct experimental evidence that enzymatic degradation proceeds primarily via the unimeric state. These results establish micelle–unimer exchange as the mechanistic gatekeeper linking polymer dynamics to biological reactivity. Beyond fundamental insight, this dynamic control enables programmed, enzyme-triggered mesophase transitions, including cascades from micelles to hydrogels and ultimately to soluble polymers. Overall, this work reframes micellar dynamics as a design tool, offering a polymer-physics framework for encoding responsiveness, selectivity, and multi-step transformations into soft matter systems.

POLYMER PHYSICS
parallel session, 15:45

Invited Lecture

Adsorption of block-copolymers on the surface of multi-walled carbon nanotubes

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Carbon nanotubes (CNTs), find attractive applications due to their unique properties. In some cases, such as polymer nanocomposites, the processing method requires their dispersion in an organic solvent. The dispersion quality strongly impacts the properties of the final nano-composite. Effective reinforcement in polymer composites requires proper transfer of stresses from the polymer matrix to the reinforcing nanotubes, which can be met by coupling agents that provide a strong interaction with the CNT surface and the matrix polymers. Coupling based on chemical reaction are not favoured as the have deleterious effects on the CNT surface, which can degrade electrical, optical and mechanical properties, and present other processing issues. Block copolymers are known to be good coupling agents by physical methods: segments with affinity for adsorption to the CNT surface can provide good anchoring, while other segments can interact with the matrix by long-chain entanglement. The objective of this research is to understand the conformation of the block copolymer adsorbed in solution onto CNTs using a model system that is known to provide effective CNT-matrix coupling. We focus in this study on multi-walled CNTs (MWCNT), for which studies on polymer adsorption are quite rare. Block copolymers of the styrene-block-4-vinylpyridine family (S4VP), adsorbed onto MWCNTs in the solvent N,N-dimethyl-formamide (DMF) serve as a model system. The morphology of the dispersed MWCNTs was studied using cryogenic transmission electron microscopy (cryo-TEM) and the conformation of the polymeric blocks was evaluated by small angle neutron scattering (SANS) measurements with contrast variation. The results show that the block copolymer adsorbs onto the MWCNT surface as a continuous coverage of low polymer concentration. PS blocks adsorb more tightly (forming a 20 Å layer containing of about 6 wt.% PS), whereas P4VP blocks emanate into the solvent, forming a thicker shell (totalling 110 Å in radius) but dilute (1%) layer, indicating chain extension. Increasing the PS molecular weight increases the thickness of the adsorbed layer but decreases the overall polymer concentration within it. These results are relevant for the ability of dispersed CNTs to form a strong interface with matrix polymers in composites, and to the ability to form CNT-CNT contacts that are important for electrical or thermal conductivity. Finally, some comparison will be made with adsorption of PS4VP from DMF onto the surface of dispersed single-walled CNTs and graphene.

Invited Lecture

Composite materials through vapor phase growth

Tamar Segal-Peretz[1]
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Vapor phase infiltration (VPI) is an emerging materials synthesis strategy that enables the formation of organic–inorganic composite materials through the controlled diffusion and reaction of gaseous precursors within polymers. Building on the principles of atomic layer deposition (ALD), VPI enables vapor-phase reactants to penetrate polymer substrates, where they react to form inorganic components distributed throughout the polymer volume, rather than being confined to the surface. This unique growth mechanism provides unprecedented control over composition, nanoscale morphology, and interfacial chemistry, making VPI a powerful tool for engineering composite materials with enhanced mechanical, thermal, optical, and functional properties.

Here, I will discuss the mechanism of VPI and our ability to control the spatial distribution of the grown materials within the polymer, as well as the development of VPI chemistries and processes such as hafnium oxide VPI. I will also present how understanding and controlling VPI and ALD growth within and on polymers can enhance the protection of polymer films against environmental conditions such as exposure to organic solvents and UV radiation, as well as enhance polymer adhesion.

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS
parallel session, 15:45

Invited Lecture

Thermoplastic composites- current development and future prospects

Olga Shalev[1], Shai Eyal[1]
Composite Materials, Rafael, Israel

Growing usage of composite materials in various industries introduces many challenges in design and manufacturing of composite based parts. Traditional thermoset fiber reinforced composites (i.e. epoxy), typically based on layup and autoclave curing, require many post-processing steps, especially with regard to large and complex three-dimensional structural parts. Additionally, since the curing process is irreversible, parts made from these materials are often impossible to repair or recycle. In the past decade thermoplastic based composites were introduced. Thermoplastic matrix (i.e. PEEK), enables producing composite laminates by application of heat and melting of the matrix, without post processing steps required. Moreover, these materials are recyclable, have excellent chemical stability, and can be easily joined with other plastic parts, without need in adhesives or mechanical bonding. In this talk we will discuss state-of-art thermoplastic composite materials- including microstructure and design, production techniques and combination with other plastic manufacturing methods, such as 3-D printing.

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS
parallel session, 15:45

Invited Lecture

A novel method for online monitoring of ambient-temperature aging of prepreg and film adhesive via direct current dielectric analysis

Erez TBA[1], Eden Elazar[2], Shaked Ben Moshe[2]
[1]*TBA, TBA, TBA*
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Carbon/epoxy prepreg and epoxy structural film adhesive ambient aging (after storage in ambient conditions) was monitored through direct current dielectric analysis. Samples were measured every week through a seven-week period. It was found that the electrical resistance of the materials is sensitive to the ambient aging that took place. Resistance results are in good agreement to differential scanning calorimetry results that were performed in parallel. Two parameters from the resistance signal are suggested for monitoring the ambient aging – 1) minimal resistance value and 2) liquification time. An ability to determine the number of days of aging time was demonstrated. This approach may serve as a novel alternative for existing aging monitoring techniques. In addition, online in-situ aging monitoring during the actual manufacturing while in the oven or autoclave is possible – enabling a novel approach to experimental quantification of material validity through serial manufacturing.

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS
parallel session, 15:45

Toward bimetallic nanowires: Insights from the co-impregnation of block copolymer films

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Institute of Chemistry and the Harvey M. Krueger Family Center for
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Jerusalem, Israel

Bimetals and alloys often display synergistic effects that give rise to non-linear properties at specific composition ranges. Confining these materials in nanowires is particularly beneficial for applications in catalysis, magnetism, and sensing owing to the high surface area and nanoscale confinement effects.

To date, ordered arrays of mono-metallic nanowires have been obtained by employing block copolymer films as sacrificial templates. In this approach, periodic arrays of nanoscale domains formed by phase separation are selectively impregnated by metal precursors. Subsequent plasma treatment eliminates the polymer film, and the metal precursors are reduced in situ into metallic nanostructures in the process. Selective co-impregnation with two metal precursors in solution seems like the next logical step toward obtaining bimetallic nanowires. However, the need to tune their composition to a desired range poses a challenge, because the resulting metal composition seldom matches the ratio of metal precursors in the impregnating solution.

In the presentation, I will describe the intricate competitive-cooperative mechanisms of impregnation that were unraveled by a deep exploration into the nature of interaction between pairs of three metal precursors (Pd, Pt, and Co) and the functional groups in the block copolymer domains. The different behaviors were successfully modelled using a single equation, which provides intuitive physical insights into the interplay between the metal precursors as they compete over binding sites.

Illustration of the competitive-cooperative co-impregnation mechanism

O. Burg, C. Cohen, R. Shenhar, *Angew. Chem. Int. Ed.*, **2025**, *64*, e202512695 (“Hot paper”).

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS

parallel session, 15:45

Insights from biology into the structure–function of composite materials

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Biological composite materials achieve combinations of properties that are difficult to replicate in engineering systems. They are inherently hierarchical and multifunctional, integrating structure and composition across multiple length scales to provide both mechanical robustness and additional functions such as protection, thermal regulation, or sensing. I will begin my presentation with examples of these systems, illustrating how natural architectures link structure to function in ways that differ from conventional materials. The next part of the talk will focus on how natural design principles can be integrated into structural materials. As a case study, I will present extrusion-based 3D printing of microalgae-derived biocomposites. Although individual microalgae cells are mechanically weak, when processed into cohesive architectures they form lightweight composites with tailored mechanical and thermal properties. By tuning rheology and printing parameters, we produced materials that combine structural integrity with isotropic insulating behavior, demonstrating how weak building blocks can be transformed into multifunctional composites using biological strategies. In the final part of my presentation, I will outline the future directions of my lab. By uncovering fundamental relationships between structure, composition, and function, we seek to build a framework for bioinspired and multifunctional composite systems that extend natural strategies into synthetic contexts.

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS
parallel session, 15:45

Grafting of polyaniline by a dynamic inverse emulsion polymerization technique onto membranes as an anti-biofouling agent: an innovative approach

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The demand for clean water is on the rise but since water sources are limited, the need for purification processes, such as membranes and filters, has become increasingly crucial. One of the main hurdles facing these processes is fouling and biofouling. In general, fouling is related to the deposition of macromolecules, colloids, particles and inorganic materials on the membrane surface and pores. Biofouling consists of the deposition of large bacterial colonies and biofilm on the membrane surface and inside the pores. Both are difficult to clean effectively. Anti-biofouling additives are typically insufficient, since they need to be stable to the water current and located at the surface of the membranes or filters. One of the suggested methods for effective biofouling prevention is the use of electrically conductive polymers (ICP).

This work describes an innovative approach for the anti-biofouling protection of membranes. This approach consists of a novel in-situ interfacial dynamic inverse emulsion polymerization process under sonication of aniline in the presence of carbon nanotubes (CNT) and graphene nanoparticles in organic solvent. The resulting hybrids were filtered, and the remaining filtration cake was used and analyzed as a nanocomposite membrane.

The resulting polyaniline (PANI) chains were grafted to the membrane surface, creating an anti-biofouling coating. High-resolution scanning electron microscopy (HRSEM) indicated that the nanocomposite membranes were coated with PANI. The grafted PANI exhibited a remarkably improved anti-biofouling effect. The membranes` salt rejection and flow properties were analyzed and showed that the flow properties were only slightly different compared to the reference membrane.

COMPOSITE MATERIALS AND ADVANCED APPLICATIONS
parallel session, 15:45

Enhancing magnetization and separation ability of superparamagnetic nanoparticles through magnetic pickering emulsions

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[2]*Institute of Agricultural Engineering, Agricultural Research Organization (ARO), Volcani Institute, Israel*

Superparamagnetic nanoparticles hold great potential as a platform for various applications due to their high surface area and their unique magnetic behavior, which is exhibited only in the presence of an external magnetic field. Nevertheless, their nanoscale results in relatively weak magnetization once exposed to an external magnet, leading to their slow separation. A significant increase in the magnetic nanoparticles diameter or their agglomeration would sufficiently increase their magnetization, however it would dramatically decrease their active surface area. In this research, we present magnetic Pickering emulsions that allow for faster and easier magnetization of the superparamagnetic nanoparticles compared to their dispersion. The assembly of magnetic nanoparticles with a large surface area on the surface of an oil droplet serves as a unique solution that allows the maximization of the magnetic field to that of agglomerates and, at the same time, maintains their high nanoscale surface area, such as in the case of highly dispersed magnetic nanoparticles. Additionally, we integrate submicron magnetic nanoparticles and (3-Aminopropyl)triethoxysilane in the emulsion to further improve the emulsion separation ability.

ADVANCED CHARACTERIZATION METHODS IN POLYMERS
parallel session, 15:45

Invited Lecture

Tailoring elasticity and relaxation of Alginate-peptide double network hydrogels

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Hydrogels composed of polysaccharides and peptides are widely recognized for their ability to partially mimic the native extracellular matrix (ECM), providing a biomimetic environment that supports and promotes cell processes. Recent research has underscored that not only these hydrogels' stiffness (represented by their storage modulus (G')) but also their stress relaxation, i.e., the ability of a substrate to dissipate cell-induced forces (represented by relaxation time (τ)) influence cells' functions. And thus,the dynamic stress-strain behavior should be modulated to optimize hydrogel performance for applications as 3D cell scaffolds. Our research aims to develop multicomponent hydrogels that will retain macroscopic stability while modeling the microscopic dynamics of native ECM and allow orthogonal control of their relaxation time and elasticity.

To that end, we have been developing a double network hydrogel consisting of a primary network of modified alginate, chemically crosslinked through hydrazone bonds between dialdehyde and adipic acid dihydrazide; Coupled with self-assembling switch peptides that form a secondary physical network only after a specific enzyme triggers a linearization of these depsipeptides to a b-sheet forming sequence.

Detailed investigation of the interplay between their viscoelastic properties and their nanostructure (characterized by SAXS , cryo-TEM, and cryo-SEM) shows that the crosslinking ratio, peptide: polymer ratio, and peptide sequence all influence the capacity to independently regulate the relaxation time and elasticity of these multi-component hydrogels.

Invited Lecture

Characterization of M-N-C carbon aerogels and their activity as oxygen reduction reaction electrocatalysts

Leigh Peles Strahl[1,2], Adi Dahan[1], Lior Elbaz[2]
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[2]*Institute of Nanotechnology and Advanced Materials, Department of Chemistry, Bar-Ilan university, Israel*

High surface area carbons have been commonly used as catalyst supports for fuel cell electrodes. A major drawback of these platforms is low catalyst utilization due to random porosity, which impedes mass transport. Carbon aerogels possess high surface area, porosity, and electrical conductivity, making them a promising alternative. However, due to the heat treatment involved in their fabrication, the structure of carbon aerogels is often ambiguous, complicating the study and optimization of catalytic systems. In this work, we present the fabrication of well-defined organic aerogels as precursors for carbon aerogels to enable a better understanding of the system. This was achieved through the modular synthesis of organic aerogels embedded with metal-coordinating ligands. Subsequent heat-treatment yielded carbon aerogels that serve as both supports and electrocatalysts for oxygen reduction reaction (ORR).

The metal complexation strategy was tailored to the specific metal-ligand pair, with metals (Fe or Cu) introduced at different stages: pre-, in situ-, or post-polymerization. Modifications of the organic aerogel structure, along with comparison between the organic aerogels and their heat-treated counterparts, enabled both improved catalyst performance and insight into the carbon aerogel structure. This was demonstrated through a systematic study of bipyridine-based aerogels, investigating the effects of ligand quantity, metal content, and metal species on the physical and electrochemical properties. Comprehensive characterization revealed a clear correlation between the metal species and loading, the aerogel structure, and the catalytic performance, achieving high ORR activity in both acidic and alkaline media. Finally, their application as cathode materials in a fuel cell operation was demonstrated.

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2) ACS catalysis, 2023, 13, 21, 14377–14384
3) ACS Applied energy materials, 2022, 5, 7997-8003

Invited Lecture

Next-generation ToBRFV diagnostics: chemiluminescence imaging for enhanced sensitivity and on-site assessment

Giorgi Shtenberg[1], Narsingh R. Nirala[1,2]
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[2]*The Robert H. Smith Faculty of Agriculture, Food and Environment, Hebrew University of Jerusalem, Rehovot, Israel*

Globally, the productivity of tomato and pepper protected farming is under threat from the newly discovered tomato brown rugose fruit virus (ToBRFV). The European Union governments have designated this virus as a quarantine organism. Specifically, ToBRFV-free tomato and pepper seeds must be approved for entry into the EU and for sale. As a result, chemiluminescence (CL) hydrogel imaging has become a potent, non-destructive method for very sensitive and specific plant pathogen detection. The use of CL imaging to identify ToBRFV in tomato plants is investigated in this work to visualize infection spatial distribution. The technique targets viral coat proteins using specific antibodies on a hydrogel containing copper ions, which exhibit peroxidase-mimetic behavior that catalyze luminol in the presence of H2O2, resulting in CL glowing. Fruit and leaf samples from both healthy and infected tomato plants were examined using a CL-imaging. The emitted photons were recorded by a smartphone camera as an inhibition of the CL signal in the presence of the viral load. Results demonstrated that the technique could detect ToBRFV at early infection stages, even in asymptomatic plants, with a detection limit surpassing traditional methods like ELISA and PCR. The imaging approach provided spatial resolution of viral distribution, aiding in understanding disease progression. Furthermore, the method is rapid, requiring minimal sample preparation, and is adaptable for high-throughput screening in agricultural settings. This study highlights the potential of CL imaging as a transformative tool for ToBRFV detection, offering advantages in sensitivity, speed, and scalability over conventional diagnostic techniques. Its integration into plant pathology could enhance early detection, improve disease management, and support sustainable tomato production.

Polymer deconstruction and circularity: insights from NMR methodology

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[2]*Department of Chemistry, Bar Ilan University, Ramat Gan, Israel*
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Despite growing public awareness, only about 15% of plastics are recycled, leaving a toxic trail in the environment and strongly impacting global health. One novel solution is to create a circular polymer–waste system, by chemically recycling plastic waste into reusable monomers, thus forming an efficient closed loop.[1]

Condensation polymers, namely polydiketoenamine (PDK) resins, are produced from triketone (TK) and amine monomers that condense spontaneously, producing water as the sole byproduct.[2] Protonation of PDK has been found to be the crucial first step of the deconstruction process. This can be tuned by changing the proton counter anion, leading to variation of the polymer water interactions and in turn, control of the depolymerization rate.[3]

Here I will present a new approach to gain atomic level insight into polymer deconstruction processes by using magnetic resonance techniques. I will show the application of multi-nuclear solid-state NMR to PDK samples at various deconstruction stages, providing molecular insight into bond activation, reaction selectivity and reactivity. Furthermore, in-situ pulsed-field gradient NMR is used as a monitoring tool for real time transformations of polymer decomposition.

The ability to understand polymer deconstruction processes and reaction kinetics will provide much needed clarity to these systems and allow further control and guidance in the design and production of future circular materials.

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ADVANCED CHARACTERIZATION METHODS IN POLYMERS
parallel session, 15:45

Probing chain orientation and crystallization kinetics in polylactic acid filaments via low-frequency and polarization-oriented raman spectroscopy

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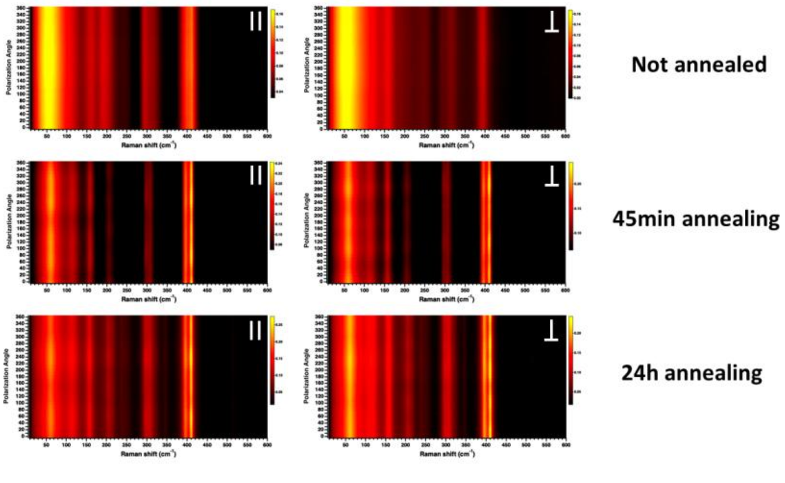
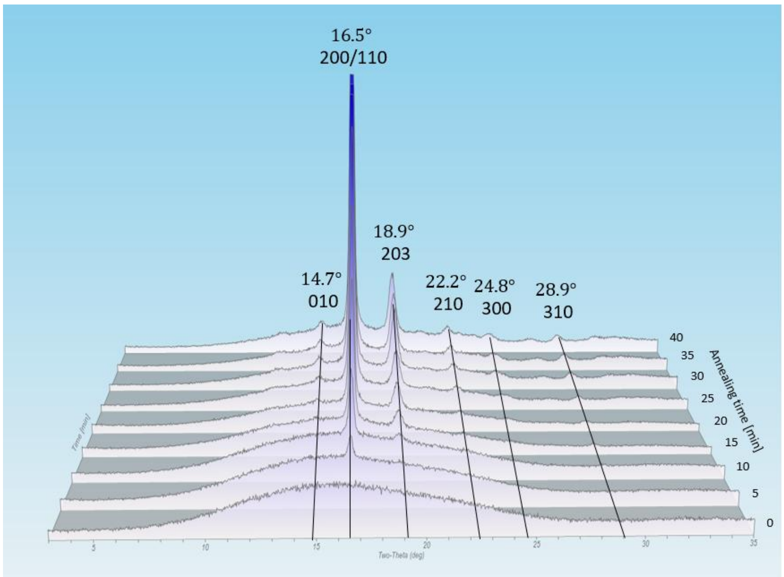
[2]*Chemical and biological physics, Weizmann Institute of Science, Rehovot, Israel*

Polylactic acid (PLA) is a leading biodegradable polymer whose crystallization behaviour strongly governs its mechanical and thermal performance. Understanding its crystallization kinetics and molecular orientation is therefore essential for both fundamental and applied research.

In this study, Low-Frequency Raman (LFR) and Polarization-Oriented (PO) Raman spectroscopy were employed to investigate PLA filaments produced by a twin-screw extruder and subjected to isothermal annealing at 110 °C. These complementary techniques enabled real-time monitoring of crystallization kinetics, molecular orientation, and chain alignment—demonstrating how the extrusion process and the associated melt flow strongly affect both chain orientation and crystallization kinetics. X-ray diffraction (XRD) measurements, conducted under both static and in-situ heating conditions, served as a complementary structural probe confirming the spectroscopic findings.

Future work will extend this multimodal framework through 4D Scanning Transmission Electron Microscopy (4D-STEM) to achieve nanoscale mapping of crystalline orientation and growth fronts. Together, these techniques provide a comprehensive approach to understanding and controlling PLA crystallization in industrially relevant systems.

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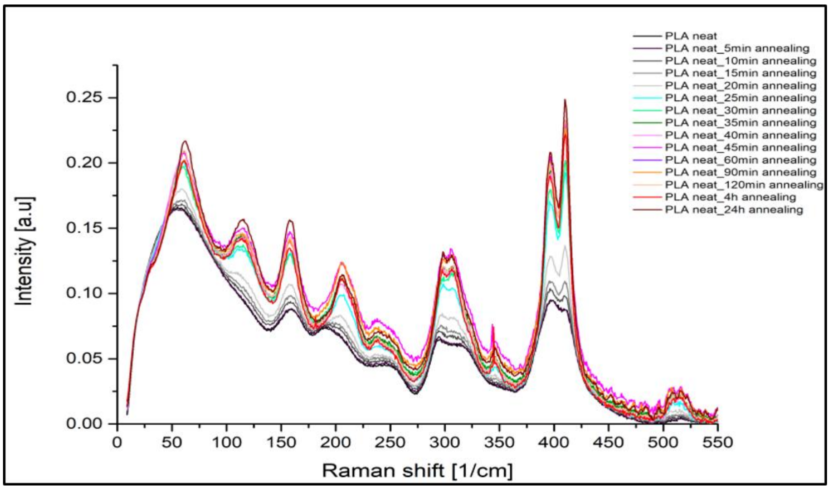
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Intensity [a.u]
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0.25
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Raman shift [1/cm]

SUSTAINABILITY IN POLYMERS
parallel session, 15:45

Invited Lecture

Prospects for circular economies in post-consumer plastics

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The growth in use of plastic materials over past decades coupled with the relatively short lifetime of many economic goods has resulted in rising levels of plastic in municipal and other waste streams. Today, leakage of plastic waste into different environmental media threatens ecosystems and ultimately human health.1, 2 To address these problems, engineering solutions to mechanically or chemically recycle post-consumer (end-of-life) plastic and aspire to attain the goals of a circular economy, also must aim to develop value-added products through "upcycling" plastic material with degraded mechanical properties. Life cycle assessment (LCA) is the key method for quantifying the environmental sustainability of evolving technology for valorizing plastic waste. This lecture reviews prospects and challenges in recycling plastic materials through mechanical and chemical routes through select case studies3, 4 pathways in an effort to provide guidelines for sustainable management of plastic life cycles.

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4. Billen, P.; Khalifa, L.; Van Gerven, F.; Tavernier, S.; Spatari, S., Technological application potential of polyethylene and polystyrene biodegradation by macro-organisms such as mealworms and wax moth larvae. Sci. Total Environ. 2020, 735, 139521.

Invited Lecture

Polymers compostability - standardized methods versus early visual and molecular indications

Yael Laor[1], Matanel Biton[1,2], Ibrahim Saadi[1], Mikhail Borisover[1]
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Industrially produced polymers are defined as compostable according to international standards. In most cases, compostability tests are based on measuring the respiration rate (respirometry) of the polymer placed in a moist mature compost, under thermophilic conditions and controlled aeration for a period of approximately six months. Such long-term measurements may create a bottleneck in the industrial development of new biodegradable polymers. Moreover, the use of mature compost, which is intended to minimize background respiration, may lead to an underestimation of degradation rates that could occur under the conditions of an active compost pile during the thermophilic phase. Therefore, alternative methodological approaches that can provide early indications of polymer degradation during composting deserve more investigation. This lecture presents short-term composting tests performed on a series of polymer samples representing different families (provided by members of the BioPlast+ consortium of the Israel Innovation Authority). Polymers samples were buried in controlled laboratory reactors or placed in pilot-scale sleeves or chambers with forced aeration. Selected samples were tested also for respirometry. During composting, samples underwent preliminary visual assessment and mid-FTIR (ATR) measurements of the surface layer. Spectral analysis included conventional approaches based on calculating absorbance peak ratios (e.g., carbonyl and hydroxyl indices), as well as application of non-negative multivariate curve resolution (MCR) analysis. The results demonstrate sufficient sensitivity to detect early chemical changes, and the challenge is to assess the expected biodegradation potential and rate on the basis of these findings.

Untying the knot: a novel, fully recyclable, multipurpose, photocurable adhesive with wide-spectral curing

Natanel Jarach[1,2], Michal Cohen[1], Rivka Gitt[1], Shmuel Kenig[2], Hanna Dodiuk[2], Shlomo Magdassi[1]
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[2]*The Department of Polymer Material Engineering, Shenkar - Engineering. Design. Art, Ramat Gan, Israel*

The widespread use of permanent thermoset adhesives in modern applications presents a significant barrier to creating a circular economy, as their irreversible bonds make recycling bonded materials nearly impossible, causing both environmental and economic challenges. This work introduces a sustainable alternative: a photocurable adhesive designed for on-demand disassembly. By incorporating dynamic disulfide linkages into the polymer backbone, we have created an adhesive that can be debonded without the need for harsh solvents or thermal treatments.

Our solvent-free system is cured by irradiation and exhibits strong bonding capabilities, comparable to commercial non-recyclable polyurethane-based adhesives, across diverse materials. The versatility of the curing process is shown through the use of different photoinitiators responsive to various wavelengths across the entire visible spectrum.

The debonding process occurs through microwave irradiation, unlike traditional high-temperature or solvent-based depolymerization processes. These findings offer a practical pathway to developing the next generation of eco-friendly adhesives.

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SUSTAINABILITY IN POLYMERS
parallel session, 15:45

Nitrogen-rich, polyethyleneimine-based, interpenetrating network porous monoliths: synthesis and application

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Interdisciplinary Program in Polymer Engineering, Technion - Israel Institute of Technology, Haifa, Israel

Highly porous, crosslinked polyethyleneimine (PEI)-based hydrogels, with amine groups in their frameworks, may offer superior performance to existing water purification adsorbents, which exhibit poor regeneration performance due to PEI leaching. Here, PEI-based monoliths with high porosities were crosslinked with bisphenol A diglycidyl ether (BPDE) within oil-in-oil medium internal phase emulsions. The formation of interpenetrating polymer networks (IPNs) was used to enhance the mechanical behavior by limiting macromolecular mobility and to modify the adsorption. The influences of the macromolecular structures, the macroporous structures, and the densities on the mechanical properties and on the adsorption were investigated.

Highly porous, emulsion-templated PEI-BPDE monoliths with different crosslinking ratios exhibited densities between 0.11 and 0.55 g/cm^3 and absorbed up to 0.25 g/g methyl orange, a model water pollutant, within one week. Monoliths synthesized using Pluronic P-123 as a surfactant exhibited a typical emulsion-templated structure and were denser, stiffer, and less adsorbent than the friable monoliths synthesized using Pluronic F-127, which exhibited a coral-like structure. IPNs synthesized using various monomers, including 4-vinylpyridine, vinyl imidazole, acrylamide, and hydroxyethyl methacrylate were investigated and IPNs based on poly(4-vinylpyridine-*co*-ethylene glycol dimethacrylate) (P(4VP-*co*-EGDMA)) were investigated in more detail. While IPN formation successfully increased stiffness, surprisingly, it did not improve adsorption (~0.15 g/g) despite the increase in void size (from 1.8 to 3.4 μm) and the decrease in density with increasing P(4VP-*co*-EGDMA) content. IPN formation with the less hydrophilic P(4VP-*co*-EGDMA) limited the swelling, reducing solution diffusion into the adsorbent. This work demonstrated that highly porous PEI-based monoliths can act as adsorbents that can be modified through the formation of IPNs.

SUSTAINABILITY IN POLYMERS
parallel session, 15:45

Hierarchical porosity in emulsion-templated block copolymer monoliths: Phase separation, degradation, and hypercrosslinking

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[2]*Department of Chemistry, Carnegie Mellon University, Pittsburgh, PA, USA*
[3]*Department of Materials Science and Engineering, Technion – Israel Institute of Technology, Haifa, Israel*

Hierarchically porous polymers with micropores (2 nm), mesopores (2 to 50 nm) and macropores (50 nm) combine high specific surface areas (SSAs) with enhanced flow and diffusion for filtration, separation, adsorption, and reaction substrates. Here, hierarchically porous polymers were designed by generating emulsion-templated macroporous monoliths based on ABA, ABA-like, or CABAC block copolymers (BCPs). The atom transfer radical polymerization (ATRP) synthesized BCPs (both thermal ATRP and photoATRP) were formulated to enable the generation of hierarchical porosities. Mesopores were introduced by selectively degrading the poly(ε-caprolactone) (PCL) B blocks. The other blocks, based on polystyrene (PS) and/or poly(glycidyl methacrylate) (PGMA), formed the structural framework. Crosslinking was effected by copolymerizing with divinylbenzene (DVB) or by reacting the PGMA epoxides with tris(2-aminoethyl)amine (TAEA). Micropores were introduced by hypercrosslinking the styrenic blocks.

Three main systems were investigated. (1) P(S-*co*-DVB)-PCL-P(S-*co*-DVB): Hypercrosslinking the BCP-like monoliths led to PCL removal and micropore formation, generating an SSA of 798 m^2/g, a pore volume of 0.359 cm^3/g, and pores ranging from 0.6 nm to 3.8 nm. (2) PGMA-PCL-PGMA: A BPC-based monolith was synthesized by crosslinking the PGMA. PCL was removed using 0.1 M NaOH, resulting in mesopores of ~11.1 nm, an SSA of 53.9 m^2/g, and a pore volume of 0.262 cm^3/g. (3) PGMA-PS-PCL-PS-PGMA: A BPC-based monolith was synthesized by crosslinking the PGMA. PCL was removed using 3 M NaOH, and the PS was then hypercrosslinked to generate an SSA of 156.9 m^2/g, a pore volume of 0.236 cm^3/g, ~5 nm mesopores, and ~1.3 nm micropores. This research has demonstrated that hierarchical porosities in macroporous emulsion-templated monoliths based on ATRP-synthesized BCPs can be pre-designed through the BCP formulation, the crosslinking strategy, and the post-synthesis modifications (etching, hypercrosslinking).

POSTER ABSTRACTS

The new tube: high-resolution cryo-em structure of an engineered protein assembly

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[2]*Biotechnology and Food Engineering Program, Guangdong-Technion Israel Institute of Technology, Shantou, China*

Protein self-assembly is a fundamental biological process, enabling proteins to spontaneously organize into highly ordered structures. Within these organized architectures, a specific category of ultrastructure assemblies, including filaments, has been associated with neurodegenerative diseases. Beyond its biological importance, this phenomenon offers significant potential for nanotechnology and biomedical applications.

My research focuses on elucidating the mechanisms underlying protein ultrastructure formation and developing strategies to engineer and control the self-assembly processes. The model enzyme, acetylxylan esterase (Axe2), from Geobacillus proteiniphilus serves as a platform to study natural octameric assemblies and to design novel ultrastructures through targeted mutagenesis.

Introducing specific mutation in Axe2, by replacing a negatively charged amino acid with a sticky hydrophobic amino acid, promoted the octamers self-assembly into filamentous structures through hydrophobic interactions. Using state-of-the-art cryo-electron microscopy (cryo-EM) methods, including single particle analysis (SPA) helical reconstruction, I resolved the novel ultrastructure, made of staggered rings forming a nanotube-like shape, at near-atomic resolution (2.6 Å). Furthermore, cryo-electron tomography (cryo-ET) revealed the helical organization of the bundled filaments making the nanotubes.

These findings establish a foundation for engineering controllable protein-based nanostructures and they contribute to a broader understanding of self-assembly as a design principle in structural biology and materials science.

Dual stimuli-responsive properties of methylcellulose/carboxymethyl chitosan mixed solutions

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[1]*Polymer Engineering, Technion, Israel*
[2]*Chemical Engineering, Technion, Israel*

Methylcellulose (MC) and carboxymethyl chitosan (CMCS) are two naturally derived polymers that each respond differently to environmental conditions. MC is known for its thermoresponsive sol–gel transition in aqueous solution, while CMCS exhibits pH-dependent solubility in water due to its carboxyl and amino groups. When combined, these polymers can interact through hydrogen bonding and electrostatic forces in solution, forming complex and tunable systems. Understanding how these interactions influence structure and phase behavior is important for designing smart hydrogels and other responsive materials for biomedical or environmental use. In this work, we examined how mixtures of MC and CMCS behave under varying conditions. Cloud point measurements were performed at different concentrations and pH values to study how both temperature and ionization affect their phase separation. To complement these macroscopic observations, we used cryogenic transmission electron microscopy (cryo-TEM) to visualize nanoscale morphologies formation of the mixture. Small-angle X-ray scattering (SAXS) provided further insight into the characteristic length scales and internal organization of the polymer assemblies, revealing how molecular arrangement changes with concentration, pH, and temperature. Together, these experiments highlight the synergistic relationship between MC and CMCS in solution. The combined thermal and pH responsiveness observed in their mixtures demonstrates how simple natural polymers can be engineered to create versatile materials with tunable, environment-sensitive properties.

Nanoscale Poly(a)morphism of PVDF Thin Films

Lior Snarski[1], Idan Biran[1,2], Sukanta Nandi[3,4], Anastasiya Sedova[1], Haim Weissman[1], Iddo Pinkas[5], Anna Eden-Kossoy[5], Sidney R. Cohen[5], Tomer Lewi[3,4], Lothar Houben[5], Boris Rybtchinski[1]
[1]*Department of Molecular Chemistry and Materials Science, Weizmann Institute of Science, Rehovot, Israel*
[2]*VISION – Center for Visualizing Catalytic Processes, Danmarks Tekniske Universitet, Denmark*
[3]*Faculty of Engineering, Bar-Ilan University, Ramat Gan, Israel*
[4]*Institute of Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat Gan, Israel*
[5]*Department of Chemical Research Support, Weizmann Institute of Science, Rehovot, Israel*

Polyvinylidene fluoride (PVDF) thin films are widely studied for their potential in sensors, actuators, and energy harvesting applications, owing to the ferroelectric properties of the electroactive β-phase. Langmuir–Blodgett (LB) technique commonly used to produce β-phase rich ultrathin PVDF films, however, despite containing a significant amount of the electroactive phase, functional ferroelectric performance requires stacking multiple LB layers. To date, the crystal structure of the active layer has been characterized using low lateral resolution techniques such as X-ray diffraction (XRD) and Fourier-transform infrared (FTIR) spectroscopy, which produce superimposed spectra from various nanometric features of the LB film. Herein, we employ four-dimensional scanning transmission electron microscopy (4D-STEM) and nano-FTIR spectroscopy to identify the polymorphs present in a single LB layer. Distinct morphological features within the LB film exhibit different crystalline phases: a well-known non-polar α-phase and a mesophase with structural characteristics resembling the β-phase.

Highly branched clustered dextrin from waxy rice starch: production, structural characterization and its role in slow digestibility

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[2]*Department of Biotechnology and Food Engineering, Guangdong Technion-Israel Institute of Technology, Shantou, China*

Starch is a natural polymer and one of the primary dietary energy sources; however, its rapid digestion can induce sharp postprandial glucose fluctuations and, over time, increase the risk of obesity. Therefore, developing starch-based materials with slow digestibility is a key strategy to enhance the nutritional value of starch. Previous studies revealed that the hydrolysis rate of waxy rice starch shows a rapid initial hydrolysis followed by a markedly reduced hydrolysis rate in the later stages. Therefore, it is hypothesized that components resistant to enzymatic degradation may be inherently present within its internal architecture.

In this study, waxy rice starch hydrolysates obtained at different α-amylase hydrolysis durations were isolated and characterized. The results revealed a highly branched, cluster-like architecture, which we designate as Highly Branched Clustered Dextrin (HBCD). The average chain length of HBCD decreased progressively with increasing hydrolysis time. In vitro digestion assays demonstrated that the combined content of resistant starch (RS) and slowly digestible starch (SDS) increased gradually during hydrolysis, reaching up to 90% of the total carbohydrate. ^{1}H NMR analysis confirmed a high degree of branching (up to 20.6%), consistent with structural features visualized through cryo-electron microscopy. The dense, branched architecture is proposed to limit α-amylase accessibility, thereby reducing hydrolysis efficiency. Differential scanning calorimetry further disclosed an endothermic transition near 105°C, indicating the presence of single-helical conformations. This structural feature suggests that HBCD may also function as a carrier for hydrophobic bioactive compounds.

Overall, these findings suggest that the hydrolysis slowdown corresponds to highly branched dextrin polymers. The HBCD, due to its smaller size and extensive branching, collectively hinders the enzymatic hydrolysis process. These findings identify HBCD as a promising starch-based biopolymer with inherent slow-digesting properties and potential applications in functional food delivery systems.

Dual composite bioadhesives for wound closure applications: An in vitro and in vivo study

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[2]*Department of Materials Science and Engineering, Tel Aviv University, Tel Aviv, Israel*
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[4]*Department of Plastic Surgery and the Burn Unit, Rambam Health Care Campus, Haifa, Israel*

Over the years, new biomaterials have been introduced as alternatives to conventional wound closure methods. Compared with sutures and staples, bioadhesives are more convenient, less time-consuming, and can provide better sealing and hemostasis. However, current topical skin adhesives such as cyanoacrylates are limited by cytotoxicity. Developing tissue adhesives with strong bonding in moist environments, tunable physical and mechanical properties, and high biocompatibility remains challenging. The present study introduces novel dual-composite bioadhesives based on highly biocompatible natural polymers gelatin and alginate, cross-linked with EDC and loaded with functional fillers: hemostatic agents (kaolin or montmorillonite) and cellulose fibers.

In vitro analyses demonstrated that the incorporation of fillers significantly improved the physical and mechanical properties of the material. Gelation time shortened from approximately 9 s to 4–6 s, while viscosity increased more than tenfold, enabling rapid and controlled application. The swelling degree decreased by over 50%, indicating a denser polymeric network. Mechanical testing showed that bonding and burst strength roughly doubled (≈ 250 → 600 kPa/mmHg), and the tensile strength and Young's modulus increased by about fourfold, confirming the reinforcing effect of the fillers. Cytotoxicity testing revealed 93% cell viability, confirming the biocompatibility of all formulations.

The in vivo porcine skin incision model demonstrated superior efficacy of these new bioadhesives compared to the control group, resulting in faster healing, reduced inflammation, and greater wound closure. In conclusion, our dual-composite bioadhesives show strong adhesion, excellent biocompatibility, and rapid setting, suggesting their potential as a suture-free alternative for wound closure and field trauma care. Their unique combination of properties makes them particularly promising for first medical response and emergency applications.

Novel antibiotic-eluting gelatin-alginate soft tissue adhesives for various wound closing applications

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Antibiotic-loaded bioadhesives have recently gained attention as a means to prevent and treat infections at wound sites while simultaneously closing the tissue. These materials can reduce the risk of postoperative infections and eliminate the need for systemic antibiotic therapy. Therefore, interest in tissue adhesives as an alternative to conventional wound closure methods has increased in recent decades due to their numerous advantages, including less discomfort, reduced tissue trauma, and lower cost. In the current study, we developed soft tissue adhesives based on gelatin and alginate, crosslinked by carbodiimide. The antibiotic drug ceftazidime was incorporated for prevention of infection. The effect of the adhesive's components on the bonding strength and swelling ratio were evaluated, as well as ceftazidime release profile and biocompatibility tests on fibroblast cells. The results showed that the bonding strength of the bioadhesives increased with the increase in its component concentrations and the incorporation of drug (antibiotic) molecules decreases the bonding strength and increases the water uptake, probably due to a decrease in the crosslinking density. Overall, the high bonding strength and good biocompatibility turns these new bioadhesives into a promising alternative for use in wound closing applications.

Cellulose fibres enhance the function of hemostatic composite medical sealants

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[2]*Department of Materials Science and Engineering, Tel-Aviv University, Tel-Aviv, Israel*

Dual-composite hydrogels represent a promising class of biomaterials whose performance can be tailored through the incorporation of functional fillers. By modifying the hydrogel's composition, these fillers influence its mechanical integrity, physical behavior, and ultimately its suitability for specific biomedical applications. This study investigates a gelatin–alginate hydrogel cross-linked with carbodiimide and reinforced with two functional fillers—kaolin, a hemostatic agent, and cellulose fibers—to enhance mechanical strength and hemostatic performance for use as a medical sealant. The effect of the formulation parameters on the mechanical and physical properties was studied, as well as the biocompatibility and microstructure. The dual micro-composite structure exhibited uniform filler dispersion and strong interfacial adhesion, resulting in significant enhancements in sealing ability (247%), tensile strength (400%), and Young's modulus (437%) compared to the unfilled hydrogel. Cytotoxicity tests confirmed high cell viability for all formulations. A comparative mathematical analysis was conducted to evaluate the combined influence of kaolin and cellulose fibers on the hydrogel's mechanical and physical performance. The relative results of each formulation were calculated with respect to the unfilled base hydrogel, and the averaged results were visualized in scatter plots. The analysis revealed a monotonic increase in mechanical performance with higher filler concentrations, demonstrating a synergistic effect at elevated fiber contents, where kaolin further enhanced strength. In contrast, improvements in physical properties—such as viscosity, gelation time, and swelling degree—were mainly attributed to fiber incorporation, while kaolin showed minimal impact. Overall, the developed dual micro-composite hydrogels demonstrate strong potential as biocompatible, high-performance medical sealants, particularly when rapid and effective sealing is required. Understanding the relationship between formulation composition and material properties enables precise optimization for various clinical applications.

Double layer and dual drug loaded microneedle patch for comprehensive skin therapy

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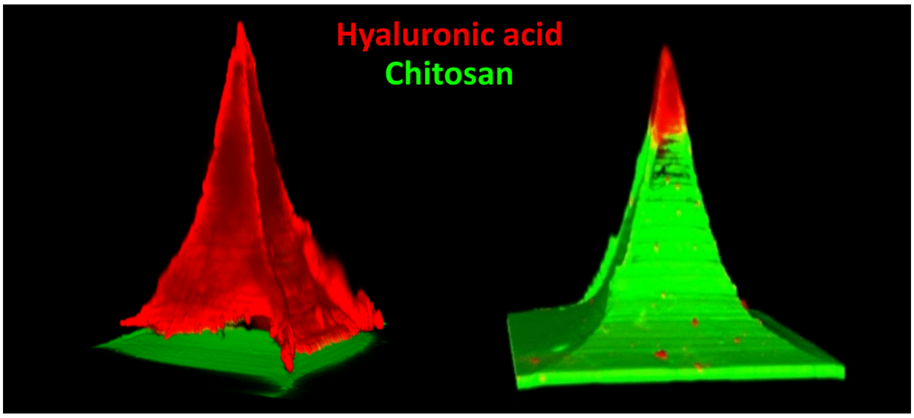
Microneedle-based drug delivery provides a minimally invasive platform for localized and controlled administration of therapeutics. However, achieving precise temporal release of multiple drugs remains challenging, particularly in clinical scenarios requiring both immediate and sustained pharmacological activity. This study presents two microneedle (MN) designs for controlled co-delivery of bupivacaine (a local anesthetic) and ampicillin (an antibiotic), using polymers with distinct dissolution profiles to modulate release kinetics.

In the first design, a double-layered MN was fabricated in which the needle tip contained a rapidly dissolving hyaluronic acid (HA)–ampicillin matrix, while the core and base were composed of chitosan loaded with bupivacaine for prolonged release. In the second design, a chitosan–bupivacaine MN was coated with an HA–ampicillin layer. Both systems exhibited uniform morphology and sufficient mechanical strength for effective skin insertion.

Spinning Disk Confocal (SDC) microscopy confirmed the spatial arrangement of the polymers. In the double-layered MNs, HA was confined to the needle tips with chitosan forming the underlying structure and minimal interlayer diffusion. In the coated MNs, HA formed a continuous external shell, while chitosan remained distributed internally.

In vitro release studies using Franz diffusion cells demonstrated rapid release of ampicillin, reaching full release within 48 hours, while bupivacaine displayed sustained release, reaching 57% over the same period.

These results show that differential dissolution properties of HA and chitosan, combined with tailored MN architecture, enable controlled dual-drug release. This platform may support clinical applications requiring immediate antimicrobial protection alongside prolonged analgesia, such as post-surgical care and wound management.



Development and mapping thermally-conductive, electrically-insulating composite coatings for thermal management of electronics

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The aggressively increased density of electronic devices, such as printed circuit boards (PCBs), demands advanced thermal management solutions. In many cases, it is recommended to coat the PCBs to ensure their protection against environmental hazards. However, traditional coatings are thermally insulating, leading to elevated temperatures and reduced performance. For effective thermal management, the coating materials must exhibit high thermal conductivity (TC 1 W m^{-1} K^{-1}) and low electrical conductivity (EC 10^{-7} S cm^{-1}) to prevent short circuits while having suitable viscosity in the liquid state to fit the required method of coating. We mapped these coating properties (EC, TC, and rheology) hence suggesting an essential design tool for most thermal management applications. We found that polymer composite-based coating, loaded with boron nitride (BN) and graphite flake (GF) fillers, provides thermal conductivity of up to 7 W m^{-1} K^{-1} while maintaining electrical insulation, suggesting an ideal coating for effective heat management. The analysis of the mapping data revealed that the hybrid GF/BN composite (17:8 GF:BN v/v) is well-suited for tape casting – a common method to coat the PCB. The composite has a thermal conductivity of 4 W m^{-1} K^{-1} while remaining electrically insulating, thermally stable, and mechanically durable. A model PCB was tape-cast by the selected composite and shows a stable decrease of up to 65 °C of the hot spot temperature. It is suggested that mapping the coating properties is instrumental in future thermal management materials development.

Characterization of resins and development of laminates for high temperature composite materials based on phthalonitrile

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High temperature composites are vital for aerospace structures due to their ability to combine low weight with strength and thermal stability. Conventional epoxy systems are limited in service temperature, while phthalonitrile (PN) resins offer superior heat and oxidation resistance, positioning them as promising candidates for advanced applications. This project focused on PN/carbon-fiber laminates, aiming to link processing conditions, laminate quality, and structural performance.

PN prepregs were cut and stacked to a defined ply schedule. Debulking cycles reduced voids, followed by vacuum bagging, curing under controlled pressure and temperature, and a post-cure to complete crosslinking. These steps produced consolidated panels with high integrity for subsequent testing.

Mechanical evaluation confirmed high stiffness and strength in the fiber direction, while interlaminar shear testing showed consistent matrix and interface response. Thermal analysis indicated stability at elevated temperatures, with a measured glass transition temperature above 300 °C. Complementary tensile testing at heat revealed an average strength of ~250 MPa compared to ~750 MPa at room temperature, demonstrating that the laminates retain a significant portion of their load bearing capacity even near the transition region. Collectively, the results demonstrate that PN laminates provide superior high temperature capability compared to conventional epoxy systems.

The study establishes the processing property relationship for PN laminates and highlights their potential as lightweight, heat-resistant aerospace materials for demanding aerospace structures. Future work will expand the mechanical evaluation with compression specimens and assess interlaminar shear stress at elevated temperatures.

Under pressure: Electrical conductivity in compressed hybrid polymer composites

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The increasing density of electronic components on printed circuit boards (PCBs) leads to localized hotspots that can degrade both performance and reliability. Composite materials engineered for high thermal conductivity (TC) and low electrical conductivity (EC) offer a promising route to manage heat while avoiding electrical short-circuits in conformal coating applications. While previous studies have shown that compression can enhance TC, the effect of compression on EC remains to be thoroughly addressed. In this study, we investigate how mechanical compression and filler formulation influence the EC of epoxy-based hybrid composites loaded with graphite flakes (GF, ~500 µm) and hexagonal boron nitride (h-BN, ~5 µm), selected to achieve both efficient heat dissipation and electrical insulation.

Our findings demonstrate that deliberate use of compression and filler ratios can tune the EC of hybrid polymer composites over several orders of magnitude. Precise control is crucial for designing conformal coatings and potting compounds that combine efficient heat dissipation with reliable electrical insulation, particularly in industrial PCB manufacturing where compression steps are already employed. Future work will explore the role of h-BN aspect ratio in percolation behavior and optimize the h-BN/GF balance to maximize TC while keeping EC below application-specific thresholds.

Silver nanowires organized in periodic arrays

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Silver nanostructures, such as nanoparticles and nanowires, exhibit remarkable properties that arise from their nanoscale confinement, which give rise to plasmonic behavior. Silver nanowires, in particular, support plasmon propagation and exhibit polarization-dependent response that varies with the angle between the long axis of the wire and the polarization angle of the incident light.

While numerous methods for the synthesis of silver nanowires are known, arranging them in ordered arrays is challenging. Hence, instead of organizing pre-formed silver nanowires, obtaining ordered arrays is usually accomplished by employing subtractive lithography schemes, which are both expensive and material-inefficient. As an alternative, templated synthesis using block copolymer films offer a versatile platform for fabricating periodic nanostructure arrays through selective infiltration of anionic metal precursors followed by plasma treatment. Yet, applying silver precursors to this method posed a challenge, as silver typically forms cationic aquo complexes that cannot infiltrate the polymer film. Additionally, silver nanostructures tend to oxidize under ambient conditions, leading to a loss of their plasmonic properties over time.

In this work we demonstrate our solution for the creation of ordered arrays of silver nanowires using block copolymer films, including different methods for countering the silver oxidation. Using patterned substrates, we achieved highly aligned nanowires, and begun exploring their optical properties.

Programmable release of encapsulated microalgae using viscosity-tuned mineral oil carriers

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The ability to program release from emulsion microcarriers remains a central challenge in engineered living materials and biodelivery systems. Here, we establish viscosity-mediated control of release dynamics in algae-loaded water-in-oil (W/O) emulsions formulated using five mineral oils of increasing viscosity (RTM-2, 3, 5, 7, 10). Emulsion morphology, phase evolution, and long-term colloidal behavior were quantified under nutrient exposure in shaken media over 30 days. High-viscosity formulations (RTM-10) exhibited robust kinetic stability, consistent with reports that viscous continuous phases suppress droplet coalescence and Ostwald ripening. Strikingly, RTM-3 emerged as a viscosity "critical point," showing near-zero release and invariant absorbance profiles, whereas RTM-2 underwent catastrophic breakup. Upon nutrient contact, intermediate-to-high viscosity systems (RTM-5 to RTM-10) reproducibly underwent from W/O to W/O/W transitions, driven by osmotic uptake and interfacial curvature inversion. Shear-induced droplet anisotropy increased as viscosity rose: RTM-5 emulsions showed partial spherical/elongated coexistence, while RTM-10 droplets fully aligned into directionally elongated morphologies under periodic shaking. The results demonstrate that relative viscosity, rather than mechanical stability alone, dictates release behavior by governing interfacial reconfiguration pathways and double emulsion formation. These findings establish viscosity tuning as a minimalistic design strategy for resilient, nutrient-responsive microencapsulation systems with programmable release profiles.

Studying the effect of surface microstructures and micro-climate on microorganisms using biomimetics and thermal imaging

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Bacterial contamination in agri-food systems poses significant challenges, affecting crops, processing equipment, and distribution networks. However, the role of surface microstructures in bacterial attachment, colonization, and biofilm formation remains poorly understood. This study investigates the interplay between leaf surface architecture, microclimate conditions, and bacterial behavior using Zantedeschia species with differing surface roughness and susceptibility to Pectobacterium brasiliense.

To isolate the effects of surface microstructure, I employed biomimetic leaf replicas, enabling isolation of the microstructural contribution to microclimate and, in turn, bacterial adhesion. Additionally, I used thermal imaging as a non-invasive method to measure temperature during droplet drying, by that assessing the kinetics of the drying process, a key factor influencing microbial attachment. Molecular biology techniques, including transcriptomic and metabolomic analyses, will further elucidate gene expression changes under varying surface conditions.

Characterization of the leaves and replicas, using AFM and contact angle, shows a significant difference in their microstructure. Preliminary thermal Imaging analysis showed differences in droplet evaporation time between the surfaces in a controlled climate chamber. Differential colonization patterns were demonstrated by SEM and confocal microscopy, showing better attachment to the more ruggedized surface.

By integrating biophysical and molecular approaches, this research aims to establish direct linkages between surface microstructures, microclimate regulation, and bacterial colonization patterns. These insights will contribute to the development of novel antimicrobial surfaces and inform strategies for reducing microbial contamination in agriculture and industrial processing environments.

Micro- and nano-sized Janus Silica Particles for compatibilization of Polyethylene Terephthalate (PET) and Polyethylene (PE) Polymer Blends

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Janus particles are specialized materials with two or more distinct surfaces or regions possessing contrasting physical or chemical properties. Due to their unique structure, Janus particles have gained significant attention in fields such as Drug Delivery, Self-Assembly, Emulsification, Sensors and Catalysis and Polymer Compatibility. Introducing the surface functionalization to silica particles surface by silane molecules offers a novel approach to produce the Janus particles which compatibilizing immiscible polyethylene (PE) and polyethylene terephthalate (PET) blends. Herein, we have developed micro- and nano-sized Janus silica particles via immobilization onto polycarbonate microsphere surface and further surface-functionalized with silane agents such as benzoyloxypropyltrimethoxysilane (BPTMS) and dodecyltriethoxysilane (DTES), offer a cutting-edge solution for compatibilizing immiscible polyethylene terephthalate (PET) and polyethylene (PE) blends. The polar BPTMS enhances interactions with the PET phase, while the nonpolar DTES improves compatibility with the PE phase, reducing interfacial tension and promoting interfacial adhesion. The synergy of these functionalities stabilizes the phase morphology, significantly improving the mechanical strength, thermal stability, and processability of the blend. The use of silane-modified Janus silica particles represents a scalable and eco-friendly strategy for advancing polymer recycling and developing high-performance PET/PE composites with applications in packaging, automotive, and textiles.

Keywords: Janus silica particle, compatibilization, PET, PE, interface, composite material

Hybrid living materials: curcumin/zein pickering emulsions for enhanced m. Brunneum pest control

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Addressing the need for sustainable agriculture, this study presents a novel Hybrid Living Material (HLM) based on Pickering emulsions stabilized by food-grade Curcumin/Zein composite nanoparticles, designed to encapsulate Metarhizium brunneum blastospores. The research involved a comprehensive characterization of leaf surface wetting, emulsion persistence, and spore distribution facilitated by the emulsion, alongside viability assessments against target insects. Results demonstrated that the emulsion significantly improved leaf wettability and minimized spore aggregation compared to surfactant-based controls. Furthermore, greenhouse assays confirmed that the encapsulated spores retained high biocontrol efficacy. This work highlights the potential of all-natural Pickering emulsions as a functional, eco-friendly platform for enhancing the delivery and performance of biopesticides

Mechanochemistry in epoxy-amine polymers

Raz Azar Buzaglo

Mechanochemistry, the transduction of mechanical force into chemical reactivity, has emerged as a powerful strategy for inducing molecular transformations within polymer systems. While extensively studied in thermoplastics, its measurement in epoxy-amine based materials remains limited due to the difficulties in quantification in conventional networks. In this work, a novel thermoplastic epoxy-amine polymer was synthesized incorporating up to 10 % of a newly synthesized rhodamine mechanophore to enable optical detection of mechanochemical activity under sonication. The central aim was to establish a new strategy for calibrating and quantifying mechanochemical activation in a thermoplastic in order to measure mechanochemistry in thermoset epoxies. Notably, the resulting thermoplastic epoxy-amine showed exceptional mechanical resilience. Even after prolonged ultrasonication at high amplitude (80%) or ball milling, the molecular weight decreased only modestly, in contrast to common thermoplastics of comparable size. This resistance to degradation highlights the potential for use in applications such as aerospace, construction, and protective coatings. Simultaneously, the study demonstrates that mechanical elongation of the polymer chains is sufficient to activate the embedded mechanophores. UV-Vis spectroscopy revealed a sonication time-dependent increase in absorbance at 538 nm, consistent with rhodamine 6G ring-opening, reaching ~56% activation after 180 min. Partial backbone scission was observed, enabling calculation of cleavage and activation rates. For a ~400 kDa polymer, one C–C bond cleaved for every ~65 mechanophores activated. Control experiments confirmed activation was mechanical and not thermally induced.

Debondable radiaton-cured adhesives

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Adhesives play a crucial role in modern life, from household use to advanced technologies. Most rely on thermoset or cross-linked polymers such as epoxy, polyurethane, and silicone resins. While these materials offer high thermal, mechanical, and chemical stability, they also pose environmental and economic challenges: once cured, they cannot be reprocessed or removed from bonded substrates without damage, leading to waste and loss of materials.

This project focuses on developing thermoset-like adhesives that combine high performance with recyclability and debonding capability, achieved through the incorporation of reversible chemical bonds, known as Covalent Adaptive Networks (CANs). In particular, adhesive formulations containing disulfide linkages were designed to enable bond exchange without the use of solvents or high temperatures, which are typically required for such systems. The absence of solvents, along with the mild synthesis, curing, and debonding conditions, offers a sustainable alternative to conventional adhesives.

The main objectives were to:

- Develop polymeric adhesives with reversible/dynamic disulfide bonds curable by light radiation.
- Create a versatile, solvent-free adhesive suitable for a wide range of substrates and curing wavelengths.
- Demonstrate recyclability and controlled debonding using simple microwave irradiation.

A novel monomer, TetraALA, was synthesized from α-lipoic acid through a one-step, efficient process. The resulting formulations exhibited rapid curing under visible light (405–630 nm) and produced strong adhesion to diverse materials. Complete debonding and recycling were achieved using household microwave irradiation, without high heat or solvents. Importantly, the adhesive retained its mechanical integrity and bonding strength after multiple cycles of reuse.

Overall, this system represents a new class of sustainable, efficient, and reusable adhesives that maintain the desirable properties of thermosets while overcoming their recyclability limitations, with potential applications extending to optical and electronic technologies.

Functionalization of supramolecular polymers using phosphate derivatives

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Supramolecular polymers are dynamic materials composed of monomers bound together via reversible, non-covalent interactions, such as hydrogen bonds. The non-covalent nature of binding imparts unique properties such as self-healing ability and environmental responsiveness. The degree of polymerization can be regulated by introducing monofunctional molecules that compete with the supramolecular monomers on the supramolecular interaction and cap the chain ends. Organic anions can serve as efficient “chain cappers” for hydrogen bonding-based supramolecular polymers. In addition to shortening the supramolecular chains, they can also be used for chain-end functionalization.

This study focuses on phosphate derivatives as chain cappers for bisurea-based supramolecular polymers, and focuses on the level of protonation as a knob to fine-tune their capping efficiency. Interestingly, self-diffusion measurements showed that partially neutralized phosphate favors the formation of a "triad" structure when present alone in solution. However, our results revealed that in the presence of the supramolecular polymer, the "triad" disassembles into an anion-cation pair and neutral phosphate. Both the anionic and neutral phosphates co-diffuse with the supramolecular chain, confirming their integration into the supramolecular polymer structure. The data evidence that the anionic species is a more efficient chain capper than the neutral phosphate.

Multifunctional, multipolymer, macroporous materials through emulsion templating

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The design of multifunctional porous polymers is of interest for applications ranging from environmental remediation to biomedical engineering. This study focuses on synthesizing multipolymer porous systems through dual-phase polymerization within high internal phase emulsions (HIPEs), employing both water-in-oil and oil-in-water systems. Hydrophobic matrices based on styrenic monomers and hydrophilic networks derived from anionic and nonionic monomers were successfully polymerized simultaneously in different phases. The macromolecular structures, porous structures, thermal properties, and mechanical properties were characterized using spectroscopy, microscopy, calorimetry, and dynamic mechanical thermal analysis. The resulting multipolymer, crosslinked polyHIPEs exhibited interconnected macroporous structures with tunable pore morphologies and low densities that were strongly influenced by the monomer compositions and the phase ratios. These results demonstrate that emulsion templating provides a versatile method for fabricating multifunctional, multipolymer, macroporous materials with designable architectures and functionalities.

Rheological behavior of branched supramolecular polymers

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Supramolecular polymers represent a unique family of polymers, in which the repeat units are connected by non-covalent interactions such as hydrogen bonds. This virtue makes them specifically intriguing, because under certain conditions they could disassemble into individual molecules and give rise to low viscosity solutions, whereas under different conditions they behave like conventional polymeric chains that tend to entangle, resulting in elastic materials. Environmentally responsiveness and self-healing are thus part of their identity.

We recently introduced branching – a fundamental aspect in polymer science – into supramolecular polymers, and showed its dramatic influence on the solution viscosity. In this work, we studied the rheological behavior of branched supramolecular polymers and compared it to the known behavior of linear supramolecular polymers. Interestingly, we found that branching leads to an unusual frequency-dependent response of the storage and loss moduli, which raises the possibility for a complex relaxation mechanism that is unique to branched supramolecular systems.

Covalent grafting of metal chelating ligand to the surface of cotton fabric for reversible binding of copper (II) ions

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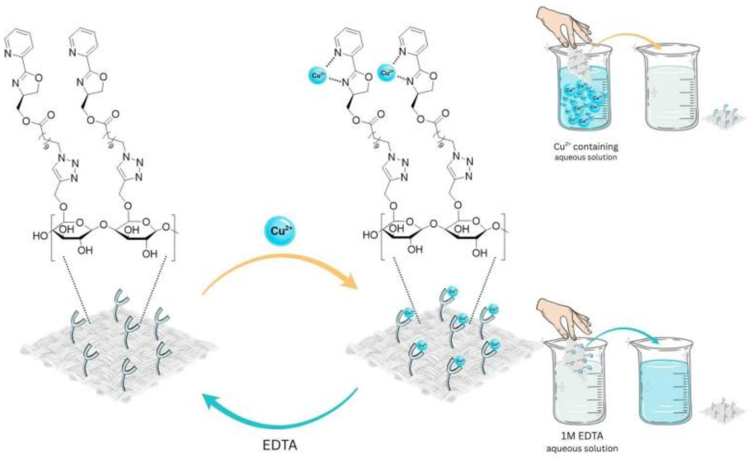
New technologies for efficient binding of heavy metals, such as copper, from diverse water sources are essential to protect environmental and human health, ensure safe water quality, and enable sustainable water reuse.

We developed a two-step method for covalent grafting of a metal-chelating Pyridine-Oxazoline (PyOx) ligand onto cotton fabric. The PyOx molecule contains an azide group enabling covalent attachment to alkyne-functionalized substrates via azide–alkyne click chemistry.

First, propargyl bromide was linked to cotton through etherification of hydroxyl groups, introducing alkyne moieties. Then, the azide-bearing PyOx ligand was attached. Fourier Transform Infrared Spectroscopy (FTIR) showed a C=N stretching peak shift from 1625 cm^{-1} to 1595 cm^{-1} upon copper (II) binding, confirming coordination.

X-ray Photoelectron Spectroscopy (XPS) revealed a Cu 2p signal at 934 eV, and Inductively Coupled Plasma–Optical Emission Spectrometry (ICP–OES) confirmed selective copper adsorption, while unmodified cotton showed no activity. The modified fabric exhibited a copper adsorption capacity of 5.6 ± 0.7 mg/g, determined by UV–Vis spectroscopy of Cu(II)–ethylenediaminetetraacetic acid (EDTA) complexation.

Reusability was validated over ten EDTA-mediated adsorption–desorption cycles, maintaining adsorption efficiency showing a consistently high recovery and robust solution for water treatments.


Cu²⁺
EDTA
Cu²⁺ containing aqueous solution
1M EDTA aqueous solution

Ionic-liquid-mediated self-assembly of sulfonated linear-bottlebrush block copolymers

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Ionic liquids (ILs), composed of bulky organic cations and anions, remain liquid under ambient conditions due to their asymmetric molecular structures. Their high ionic conductivity, coupled with negligible vapor pressure, makes them attractive candidates for next-generation electrolytes. However, to enable their practical implementation, these liquids must be immobilized within solid frameworks that preserve ion transport. A promising approach to achieve this goal is the incorporation of ILs into block copolymers (BCPs), macromolecules composed of covalently linked, chemically distinct polymer segments that spontaneously self-assemble into well-defined nanostructures such as lamellae, cylinders, gyroids, and spheres. This microphase separation allows precise control of morphology and physical properties through molecular design and chemical modification.

Bottlebrush block copolymers (BBCPs) represent a unique subclass of BCPs, in which densely grafted side chains along a central backbone suppress chain entanglement and impart remarkable softness and dimensional stability. Their tunable architecture and narrow dispersity enable systematic manipulation of nanoscale order and mechanical properties.

In our work, we design hybrid systems composed of a linear BCP block that provides structural integrity and a BBCP block that enhances flexibility. Sulfonation of the linear block introduces acid functionality, promoting selective partitioning of the ILs into the modified domain and directing the self-assembled morphology. This system offers a versatile platform for the development of mechanically robust, ion conducting materials for advanced electroactive applications.

Dually selective polymeric membrane for charge-specific and solvent transport using diversely structured copolymers

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Polymeric membranes are essential for selective transport in electrochemical and separation technologies. However, most current membranes target the transport of a single molecular species, typically in one direction. This study aims to develop a copolymer-based membrane capable of dual selectivity, where ions and neutral solvents are transported through distinct polymer phases in opposite directions.

The proposed membrane design integrates a quaternary ammonium (QA)-functionalized block for hydroxide ion conduction with a triethylene glycol (TEG)-containing block for water/methanol transport, leveraging their distinct hydrophilicity and Flory–Huggins interaction parameters. Using reversible addition–fragmentation chain transfer (RAFT) polymerization, we synthesized homopolymers, random copolymers, and block copolymers with controlled composition and molecular weight to investigate how polymer composition influences self-assembly, ionic conductivity, and solvent transport, both independently and simultaneously.

Characterization through gel permeation chromatography (GPC), nuclear magnetic resonance (NMR), and small-angle X-ray scattering (SAXS) is employed to correlate molecular structure with morphology and transport behavior. This work is expected to provide new insights into the design of multifunctional membranes that enable coupled charge and solvent transport, with potential applications in fuel cells, sensing, and water management systems. In addition, it will provide fundamental understanding on how transport in opposite directions affect each other.

Mucoadhesive double network hydrogels for sublingual drug delivery

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Sublingual drug delivery offers rapid systemic absorption without first-pass metabolism, but conventional sublingual formulations often suffer from limited drug retention due to insufficient mucoadhesion and poor mechanical strength. To address these limitations, we developed a mucoadhesive double network (DN) hydrogel specifically for sublingual drug delivery. The hydrogel comprises a chemically crosslinked network of water-soluble chitosan derivatives interpenetrated with a flexible network.

DN hydrogels were prepared by chemically crosslinking the chitosan derivative network with physically crosslinking the second network. The hydrogels were characterized using Fourier transform infrared (FTIR) spectroscopy, mechanical testing, mucoadhesion studies on ex vivo porcine sublingual tissue, and swelling under various pH conditions to evaluate pH responsiveness. The DN formulation exhibited higher mechanical strength compared to single-network hydrogels. It also showed a good mucoadhesion at physiological and showed enhanced swelling at neutral pH. These combined properties suggest that the DN hydrogel can prolong drug residence time in the sublingual region. In conclusion, this mucoadhesive double network hydrogel represents a promising platform for sublingual drug delivery by combining enhanced mucoadhesion with improved mechanical stability and controlled drug release.

Modeling and validation of film/foam multilayered structures for acoustic applications

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Multilayer co-extrusion is a process that has been extensively studied over the years, resulting in the knowledge of control over mechanical, thermal, and optical properties. Each layer of the multilayer structure possesses unique properties, enabling the design of sheets fitted to the specific application. The changed morphology of foamed layers within the multilayer structure plays a crucial role in the acoustic behavior of the sheet. The presence of air-filled voids causes multiple reflections, dissipating sound energy within the structure. This study investigates the impact of the thickness ratio of film/foam polyethylene (PE) multilayered sheets on their acoustic properties. For that, COMSOL Multiphysics® software was used to model various multilayer structures, allowing for detailed simulations to predict their acoustic behavior. These numerical analyses provided valuable insights into the acoustic performance of the materials before conducting physical tests. The results from the simulations helped optimize material properties and design parameters. Following the simulations, the acoustic behavior of the multilayered sheets was validated through laboratory testing using an impedance tube. This combination of modeling and experimental testing contributed to a comprehensive understanding of the acoustic properties of the film/foam structures. Ultimately, this research aims to develop advanced acoustic insulation solutions for the automotive industry by addressing the challenges and exploring the potential of these structures.

Collapse of a single polymer chain: Chain stiffness and attraction range effects

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Chain-like macromolecules in solution, whether biological or synthetic, transform from an extended conformation to a compact one when conditions such as temperature change. This collapse transition is relevant in various phenomena, including DNA condensation, protein folding, and the behavior of polymers in solution. We investigate the interplay of chain stiffness and range of attraction between monomers in the collapse of a single polymer chain, using Monte Carlo simulations. Two distinct behaviors are found depending on chain stiffness (represented by the persistence length l_p) and attraction range r_c. When l_p is larger than r_c, the chain collapses sharply with decreasing temperature, whereas if l_p is shorter than r_c, it contracts gradually. For small r_c the transition temperature (θ-temperature) increases with l_p, whereas for large r_c the θ-temperature decreases with l_p. Thus, stiffness promotes collapse for small r_c but suppresses it for large r_c. Our findings are in agreement with recent experiments on the contraction of single-stranded RNA as compared to double-stranded DNA, and provide valuable insights for understanding polymer collapse and guiding material design.

Fabrication of flexible and conductive components using digital light projection 3D printing of photochemical resins for soft robotics applications

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Contemporary scientific and industrial challenges demand innovative solutions grounded in advanced manufacturing technologies. Among these, 3D printing has emerged as a transformative approach, reshaping conventional production methods and enabling new frontiers in material design. One of its most promising applications lies in the field of soft robotics, where systems are required to perform complex and delicate tasks with high precision in agriculture, medicine, and space exploration. Examples include grasping fragile objects, navigating heterogeneous environments, and probing sensitive surroundings.

The fabrication of such robots requires elastomeric components with exceptional mechanical performance, including high stretchability, flexibility, shape-memory effects, and self-healing capabilities. Meeting these requirements calls for the integration of functional materials that extend beyond conventional polymers.

This study focuses on the incorporation of nanowires into photo-curable polymer matrices to enhance electrical conductivity and sensing properties in soft robotic systems. In addition, the study examines their effect on the Digital Light Processing (DLP) 3D printing of polymeric inks, with the aim of optimizing printability and structural performance.

By combining advanced nanomaterials with additive manufacturing, this work seeks to establish new design strategies for electrically conductive, flexible architectures. The findings are expected to contribute to the development of next-generation soft robotics with improved sensing, adaptability, and application potential in diverse technological domains.

6. Polymer Processing and 3D Printing

3D printing of edible Pickering emulsions based on pea protein – κ-carrageenan nanoparticles

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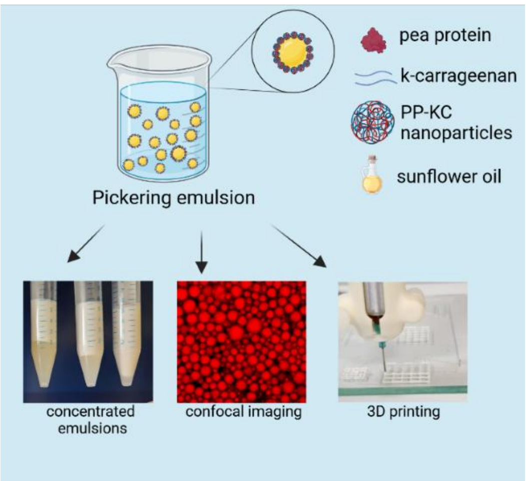
Pickering emulsions (PEs) can be utilized as inks for 3D food printing owing to their extensive stability and appropriate viscoelastic properties. This research explores food-grade PEs stabilized with nanoparticles (NPs) based on modified pea protein (PP) isolate and k-carrageenan (KC). NPs are fabricated from solutions with different concentrations of protein and polysaccharide and characterized in terms of size, zeta potential, and wetting properties. The composition of the emulsion is 60% sunflower oil and 40% aqueous phase. Nine emulsion formulations with varying PP and KC concentrations are investigated. The formation of hollow NPs with a hydrodynamic diameter of 120 nm–250 nm is observed. Microscope imaging shows oil droplets surrounded by a continuous aqueous phase, forming homogenous PEs at all formulations that are stable for over 30 days. Further, the oil droplet size decreases with increasing NP concentration while the viscosity increases. Rheologic experiments portray elastic emulsion gels with thixotropic qualities ascribed to the presence of the polysaccharide. The emulsions are subjected to centrifugation in order to compare the original emulsions to concentrated PEs that show improved capabilities to serve as sustainable and printable, saturated fat alternatives due to their composition, texture and stability and rheological properties. Lastly, PEs are printed smoothly and precisely while maintaining a self-supported structure paving way for creating improved, innovative food alternatives.



Smart drug release platform for facile in vitro testing of therapeutic effects

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Approving a new drug requires approximately 5 years as part of a total of 20 years of development because of the need to develop special formulations during the initial phase of drug discovery. Our research aims to create a new platform that will eliminate the need for these formulations and thus considerably shorten the time necessary to discover and develop new drug leads.

The platform, which we term ‘DrugBurst’, is composed of several layers that enable the on-demand release of incorporated drugs. The first layer is a block copolymer film serving as a nanopatterned template. Alternating deposition of biocompatible polycations, electroactive polyanions, and drug molecules furnishes polyelectrolyte multilayers which incorporate the drug. Applying a low voltage causes the disassembly of the multilayers, which releases the drug in a burst. Preliminary results of applying this approach to cells adsorbed onto the platform demonstrate highly efficient uptake, which enables testing the therapeutic effect of the drug on the cell without the need to develop special formulations.

This study focuses on expanding the utility of the DrugBurst platform to different drugs and testing them using different target cells. We aim to demonstrate the generality of our approach to anti-cancer, anti-inflammatory, and anti-bacterial drugs.

Phase behavior of methylcellulose-based amphiphilic biocompatible block copolymers in solution

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Methylcellulose (MC)-based block copolymers (BCPs) offer exciting potential for smart and biocompatible drug delivery systems. MC is a water-soluble, non-toxic polysaccharide that exhibits unique thermoresponsive behavior—undergoing a reversible sol-gel transition upon heating, driven by nanofibrillar network formation. In this study, we synthesize and characterize novel MC-based amphiphilic BCPs and explore their self-assembly and thermogelation behavior in aqueous solution. Using cryogenic transmission electron microscopy (cryo-TEM), we show that the BCPs self-assemble into micellar nanostructures at room temperature, while at elevated temperatures they form an interconnected fibrillar network originating from the micellar hydrophobic cores. These responsive systems can encapsulate and protect sensitive or poorly soluble drugs, allowing for controlled and localized release triggered by temperature changes. We expect these polymers to provide a versatile platform for the development of advanced, responsive, and safe drug delivery systems with improved therapeutic performance.

7. Polymers in Nanomedicine/Nanomaterials

Hydrogel formulation for sustained release of biomimetic nanoparticles

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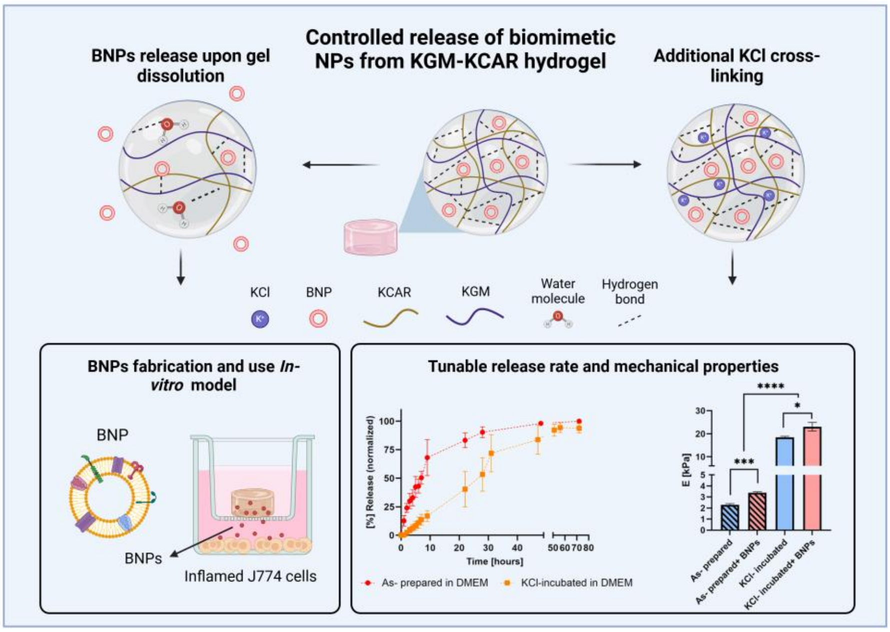
Hydrogels, 3D cross-linked polymeric networks, have diverse biomedical applications, particularly in drug delivery. Incorporating nanoparticles (NPs) into hydrogels can enhance therapeutic effects by enabling more targeted and sustained release. Biomimetic NPs (BNPs), which integrate leukocyte membrane proteins and were developed by Dr. Assaf Zinger`s group, offer significant potential for therapeutic outcomes. However, due to their nanometric size, the controlled release of these BNPs from the hydrogel network cannot occur via a diffusion mechanism.

This study aims to develop a double network hydrogel platform for the controlled release of novel BNPs. The hydrogel dissolves at physiological conditions, allowing the BNPs to release and evaluate its therapeutic effects. We focus on creating a physically cross-linked IPN hydrogel using konjac glucomannan (KGM) and kappa-carrageenan (KCAR) polysaccharides, with embedded BNPs. The study investigates the physical, mechanical, and rheological properties of the hydrogels, including their ability to release BNPs at a controlled rate. We also assess the therapeutic effects of this release in vitro inflammation model.

The results demonstrate the successful fabrication of KGM-KCAR hydrogels incorporating BNPs. The hydrogels exhibited self-healing and shear-thinning properties, with tunable dissolution and BNP release rates, influenced by potassium chloride (KCl) as a physical cross-linker. Additionally, the formulation reduced TNF-alpha cytokine levels in an in vitro inflammation model, without significantly affecting cell viability. This research suggests that the KGM-KCAR hydrogel platform offers a promising approach for controlled release of BNPs, providing therapeutic potential in various medical applications.


Controlled release of biomimetic NPs from KGM-KCAR hydrogel
BNPs release upon gel dissolution
Additional KCl cross-linking
KCl
BNP
KCAR
KGM
Water molecule
Hydrogen bond
BNPs fabrication and use In-vitro model
BNP
BNPs
Inflamed J774 cells
Tunable release rate and mechanical properties
[%] Release (normalized)
0
25
50
75
100
Time [hours]
0
10
20
30
40
50
60
70
80
As- prepared in DMEM
KCl-incubated in DMEM
E [kPa]
0
1
2
3
4
5
10
20
30
***
****
*
As- prepared
As- prepared+ BNPs
KCl- incubated
KCl- incubated+ BNPs

Nanoparticles Synthesized from Soy Protein for DNA Delivery and Antifungal Material Delivery

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The efficient delivery of genetic material into plant cells remains a major challenge in plant biotechnology due to the presence of the rigid cell wall and the limitations of existing transfection methods. Nanocarrier-based delivery systems offer a promising alternative for transient gene expression and genome modification without relying on biological vectors or DNA integration [1, 2]. In this study, we developed soy protein-based nanoparticles (SPs) as biodegradable, biocompatible nanocarriers for nucleic acid delivery into plant and fungal cells. Soy protein isolate (SPI) was used to synthesize nanoparticles through a desolvation method, followed by surface modification with poly-L-lysine (PLL)—a polymer derived from the amino acid lysine—to achieve a positive zeta potential suitable for electrostatic binding of plasmid DNA.

Comprehensive characterization was performed using Dynamic Light Scattering (DLS) and ζ-potential analysis to determine particle size and surface charge. Fluorescent labeling of SPs with fluorescein isothiocyanate (FITC) enabled visualization of their cellular internalization by confocal microscopy. The uptake and distribution of SPs were examined in Aspergillus flavus spores and Nicotiana benthamiana leaf tissues, revealing successful penetration and intracellular localization of the fluorescently labeled particles.

These preliminary results suggest that soy protein nanoparticles have strong potential as sustainable, protein-based nanocarriers for gene delivery applications in both plant and fungal systems. Further studies are underway to evaluate their DNA-binding capacity, delivery efficiency, and biological compatibility to fully establish their suitability for biotechnological applications [1–3].

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Development of Zein protein nanoparticle for Targeted Delivery of Genetic Material and Antifungal Compounds

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The development of sustainable and biocompatible nanocarriers is of growing interest in biotechnology, with applications ranging from drug and gene delivery to agricultural protection. Nanoparticle-based systems offer controlled release, high stability, and improved cellular uptake of bioactive compounds [2]. In this study, zein protein nanoparticles (ZPs) were developed as biodegradable carriers for the delivery of genetic material and antifungal agents. Zein, a hydrophobic corn storage protein recognized as safe (GRAS), provides a renewable and biocompatible platform for encapsulation and targeted delivery applications [3].

ZPs were synthesized using the anti-solvent precipitation method, followed by covalent labeling with 6-aminofluorescein (6AF) for fluorescence visualization. Characterization by Dynamic Light Scattering (DLS) and zeta potential analysis confirmed nanoscale size and suitable surface charge for electrostatic interaction with DNA. Confocal microscopy demonstrated that fluorescently labeled ZPs successfully penetrated both Nicotiana benthamiana leaf tissues and Aspergillus flavus fungal cells, suggesting their ability to cross biological barriers.

These preliminary findings indicate that zein nanoparticles could serve as versatile nanocarriers for dual delivery purposes—transporting plasmid DNA into plant cells and carrying antifungal compounds into fungal pathogens. Further investigations will focus on optimizing DNA binding, evaluating gene expression efficiency, and assessing antifungal performance relative to conventional treatments. This work highlights the potential of plant-derived protein nanomaterials to contribute to sustainable innovations in plant biotechnology and crop protection [1–3].

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Can plastic nanoparticles be detected selectively?

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The toxicity of plastic nanoparticles (PNPs) raises the need for comprehensive research. Indeed, PNPs pose severe threats to aquatic species, affecting their health and ecosystems. Unlike microplastics, PNPs can penetrate biological barriers, including the gastrointestinal tract, leading to bioaccumulation and potential toxicity at the cellular level. Their small size increases exposure risks, raising concerns about long-term environmental impacts. The nanoparticle-imprinted matrix (NAIM) is an approach aiming to selectively identify and detect nanoparticles (NPs). This research focuses on the fabrication of highly specific conductive nano-cavities on a non-conductive surface, the recognition and reuptake of PNPs, the characterization and analysis of all process stages using a variety of methods, and the development of an initial solution to reduce the toxicity of PNPs in the environment. In this research, spherical polystyrene-based PNPs, which are partially negatively charged, were imprinted in a sol-gel matrix following a few steps. The PNPs were first adsorbed onto a Pt surface coated with a positively charged polymer, i.e., polyethylenimine. A sol-gel matrix was electrochemically deposited following the pH-potential induced approach. Hence, a negative potential of -0.9 V was applied for a period to form a continuous, uniform film. The PNPs were entrapped in the sol-gel matrix. Then, the PNPs were removed by washing with an organic solvent to form nanocavities bearing the shape of the PNPs. The next step is to examine the ability of the nanocavities to reuptake selectively the originally imprinted PNPs.

Engineering reverse thermo-responsive (RTR) nanofibers

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Introduction: Polymers exhibiting reverse thermo-responsive (RTR) behavior are known for their temperature-dependent phase transition in aqueous media, forming a solution below and a gel above the transition temperature. This property makes them highly useful for biomedical applications including injectable drug delivery and bio-adhesives. This research aims to integrate nanotechnology and RTR materials by developing RTR nanofibers as building blocks for innovative nanostructures. The generated substance is based PF, Poly(F127) an RTR polymer, consists of polyethylene oxide–polypropylene oxide–polyethylene oxide (PEO-PPO-PEO) triblock chain-extended via hexamethylene diisocyanate. To enhance the fibers physical stability, FdMA, a similar RTR polymer synthesized using IEMA (2:1) and SnOct2, was incorporated to create semi-interpenetrating networks (semi-IPNs). Generated substance was characterized via NMR and rheometer. Nano fibers were engineered and optimized via electrospinning process and SEM microscope.

Goals:

* Develop the RTR-displaying building blocks for creating semi-IPNs.

* Generate semi-IPN systems.

* Engineer electrospun structures displaying the required RTR behavior.

Result and discussion:

* PF and FdMA were synthesized, viscosity studied with rheometer, water dissolute and absorption where obtained. 9 Different ratios of FdMA:PF prepared and inserted to ESP machine.

* FdMA found efficient at 3% doping concentration. Fibers Failed after crosslinking with TPO in few different UV time exposure.

Renewable resource polymers for encapsulation of organics for thermal energy storage-release

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The development of porous polymeric structures using renewable resources is of growing interest for sustainable energy storage applications. This work involves the interfacial step-growth polymerization synthesis of polyHIPEs, polymerized high internal phase emulsions (HIPEs), based on renewable resource polyphenols (e.g., tannic acid, lignin) within oil-in-water HIPEs stabilized either by a polysaccharide (e.g., alginate) or by amphiphilic nanoparticles. The organic internal phase contains liquid phase change materials, such as hexadecane, octadecane, and eicosane, for thermal energy storage-release. The porous structure was characterized using scanning electron microscopy and the thermal properties were characterized using differential scanning calorimetry, dynamic mechanical thermal analysis, and thermogravimetric analysis. Stable emulsions with high internal phase content were obtained using both stabilization strategies, with distinct differences in the resulting porous structures and thermal behaviors. These results highlight the potential of renewable resource-based HIPE systems for thermally responsive and environmentally sustainable energy storage-release applications.

Effect of UVB irradiation treatment of plastic polymers on biofilm formation of Alcanivorax xenomutans bacteria

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The accumulation of plastic waste in marine environments has become a worldwide problem, leading to various ecological problems that affect marine organisms. In the ocean, plastic debris is continuously exposed to environmental factors such as water currents, winds, waves, and ultraviolet (UV) radiation from the sun. Over time, these surfaces become colonized by various microorganisms that interact with one another and with the plastic substrate through biofilm formation.

Bacteria of the genus Alcanivorax, which are known to degrade hydrocarbons, are commonly found in the plastisphere in the Mediterranean Sea, particularly on polyethylene (PE) polymers.

In this study, PE and polyethylene terephthalate (PET) surfaces were exposed to strong UVB radiation for seven days, causing polymer degradation. We then examined the biofilm-forming ability of A. xenomutans on both treated and untreated surfaces. The results showed that the bacterium formed denser biofilms on untreated PE than on UV-treated PE, whereas on PET the opposite trend was observed- more biofilm was formed on treated PET than on untreated PET.

This research provides new insights into bacterial behavior within the plastisphere and contributes to understanding how biofilm formation on different plastic types affects their ability to degrade hydrocarbons. These results may assist in finding new possibilities in the control of plastic pollution in the oceans.

The effect of UVB irradiation treatment of plastic polymers on the biofilm formation of Alcanivorax balearicus bacteria

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As the plastic industry grows, the problem of marine plastic pollution worsens. One immediate effect is that plastic waste serves as a substrate upon which microorganisms may grow, creating a new ecological niche called the “plastisphere.” To help solve this problem, science seeks ways to use bacteria found in the plastisphere to treat plastic waste. Researchers are trying to increase the biofilm produced by Alcanivorax bacteria, known for degrading oil, and some species may also degrade plastic.

This study examined how UVB irradiation of plastic surfaces - Polyethylene (PE) and Polyethylene terephthalate (PET) - affects the adhesion of Alcanivorax balearicus and the plastics’ physical and mechanical properties.

In the first stage of the research, the plastic surfaces were irradiated with UVB light, and changes were examined using SEM to observe morphology, FTIR for chemical composition, and a water contact angle test for hydrophobicity. Irradiation caused visible alterations such as scratches and fractures, decreased hydrophobicity, and formed a new chemical bond in the PE surface.

In the second stage, the amount of biofilm formed by A. balearicus on irradiated versus non-irradiated plastics was compared to determine the effect of UVB on biofilm formation. The bacteria were grown near plastic samples, stained, and quantified. Results showed a decrease in biofilm formation on irradiated surfaces.

The results show that it is likely that UVB irradiation alters the structure and composition of plastic and reduces the ability of A. balearicus to attach to the surface and establish itself.

Incorporation of surface-treated recycled plastic into concrete

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Sustainable construction requires circular routes that upcycle plastic waste into durable, structural material streams. This study evaluates recycled polypropylene (rPP) and recycled polyethylene (rPE) as partial replacements for coarse aggregates in concrete, emphasizing interface engineering so recycled plastics act as bondable aggregates rather than inert fillers. Two independent strategies were investigated:

(1) Hydrophilization of polymer surfaces via alkaline treatment, low-power air-plasma, or a combined plasma–alkaline sequence; and

(2) Nanocomposite compounding of the recycled polyolefins with Cloisite nanoclays to modify matrix polarity/roughness and interfacial behavior.

Surface and bulk changes were characterized by contact-angle goniometry, FTIR-ATR, SEM/EDS (including oxygen enrichment and morphological roughness), and rheological indices; modified plastics were then incorporated into concrete specimens for mechanical evaluation at standard curing ages. Within the hydrophilization route, controlled air-plasma exposure produced robust, persistent oxygen-bearing functionality at the plastic surface. Pairing plasma with a mild alkaline step 5% NaOH,1h balanced wettability gains with practicality, whereas higher alkali strength yielded diminishing returns. In the separate nanoclay route, judicious Cloisite loading increased apparent hydrophilicity and facilitated interfacial bonding, with the anticipated tradeoff of reduced melt-flow index; this can be addressed via admixture selection and mix-design tuning.

Microstructural evidence from fracture surfaces and interfacial regions indicated a tighter interfacial transition zone and visibly improved polymer–cement adhesion in both routes, consistent with mechanical response trends. While none of the systems surpassed the reference concrete, optimized hydrophilization and, independently, optimized nanoclay compounding each narrowed the performance gap and produced reproducible gains over untreated mixes.

Overall, the results outline two complementary but distinct pathways to eco-efficient, circular concretes using surface-engineered or nanocomposite recycled polyolefins. These pathways are scalable, cost-aware, and safer than aggressive chemistries, and they define clear next steps—workability optimization, shrinkage control, long-term durability, and standardization.

Developing alternative protein from yeast grown on a substrate made from corn plant biomass

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Rising concerns about sustainability, food security, human health, and animal welfare, drive the shift to sustainable alternatives to animal-based food protein. Yeast is a great alternative source of proteins and nutrients, which may also be grown on agrifood side-streams to valorize them. Cereals are massive global crops, whose unused parts become waste or animal feed. We pretreated corn plant biomass (CPB), hydrolyzing its cellulose/hemicellulose, to obtain a rich substrate, which we used to grow biomass of a generally regarded as safe (GRAS) yeast strain, Yarrowia lipolytica. The CPB medium is richer than YPD medium (gold standard for yeast, Figure 1) and can even be diluted 2-fold without reducing its ability to support yeast cultivation (Figure 2). After which the yeast cells are disturbed, and their contents are fractionized to achieve a protein-rich liquid that we would create an alternative protein food product from.

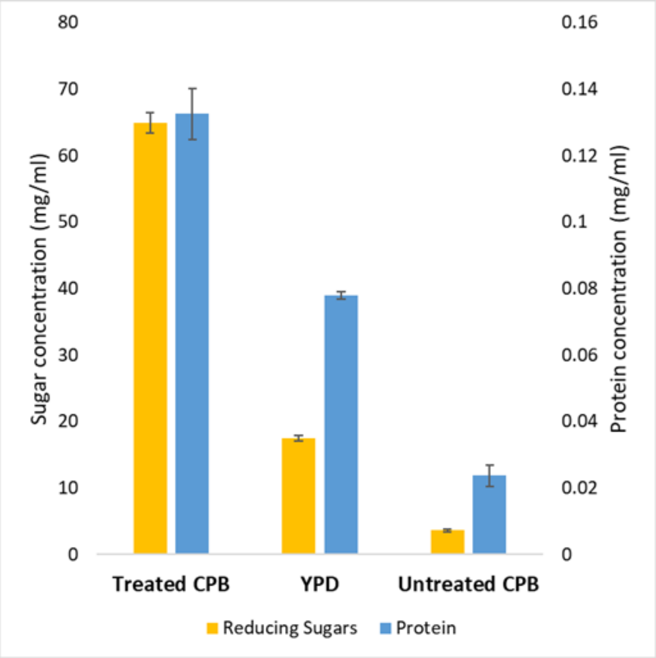

Figure 1: The final sugar and protein concentration of the treated and untreated CPB and YPD.

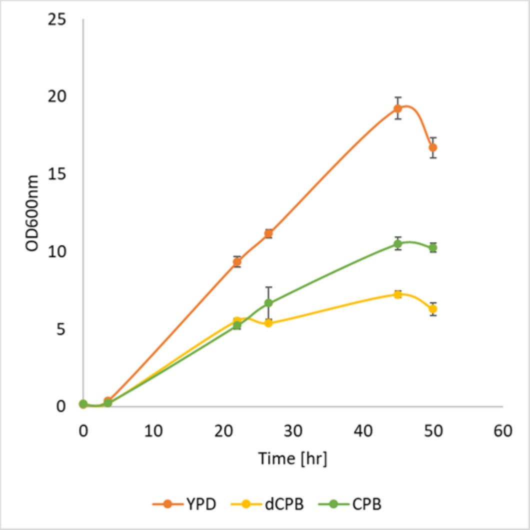

Figure 2: Yeast growth over time on different media. dCPB is CPB medium diluted 2-fold.

Enhancing composite materials performance at elevated temperatures using atomic layer deposition

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[2]*X, X, Israel*

Composite materials are increasingly used as advanced structural materials in versatile applications, as they offer high specific strength and low weight. However, in applications such as high-speed aviation, where the composite materials are exposed to elevated temperatures and oxidative conditions, their performance is limited. Carbon fibers are susceptible to oxidation-induced degradation at temperatures above 400°C, resulting in reduced mechanical integrity. This research investigates the application of atomic layer deposition (ALD) of metal oxides to improve the thermal and oxidation resistance of carbon fiber-polymer composites.

ALD is a vapor-phase technique capable of depositing uniform, conformal thin films with sub-nanometer precision. In this study, we utilize ALD to achieve uniform coatings on carbon fibers, both in bare form and embedded within a polymer matrix, and probe their mechanical performance at elevated temperatures (300°C-600°C). We conformally deposited nanometric Al2O3 coatings on the carbon fibers, evident from our scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) characterization. These Al2O3-coated fibers showed superior oxidation resistance, characterized via tensile testing and thermogravimetric analysis (TGA).

This work contributes to the development of thermally resilient composite materials and demonstrates the potential of ALD as a surface engineering tool for composites use at challenging environments.