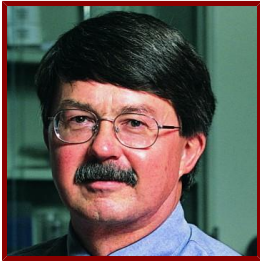


Stanford



Curtis Frank

W. M. Keck, Sr. Professor in Engineering, Emeritus
Chemical Engineering

Bio

BIO

The properties of ultrathin polymer films are often different from their bulk counterparts. We use spin casting, Langmuir-Blodgett deposition, and surface grafting to fabricate ultrathin films in the range of 100 to 1000 Angstroms thick. Macromolecular amphiphiles are examined at the air-water interface by surface pressure, Brewster angle microscopy, and interfacial shear measurements and on solid substrates by atomic force microscopy, FTIR, and ellipsometry. A vapor-deposition-polymerization process has been developed for covalent grafting of poly(amino acids) from solid substrates. FTIR measurements permit study of secondary structures (right and left-handed alpha helices, parallel and anti-parallel beta sheets) as a function of temperature and environment.

A broadly interdisciplinary collaboration has been established with the Department of Ophthalmology in the Stanford School of Medicine. We have designed and synthesized a fully interpenetrating network of two different hydrogel materials that have properties consistent with application as a substitute for the human cornea: high water swellability up to 85%, tensile strength comparable to the cornea, high glucose permeability comparable to the cornea, and sufficient tear strength to permit suturing. We have developed a technique for surface modification with adhesion peptides that allows binding of collagen and subsequent growth of epithelial cells. Broad questions on the relationships among molecular structure, processing protocol, and biomedical device application are being pursued.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Chemical Engineering
- Member, Bio-X
- Member, Cardiovascular Institute

HONORS AND AWARDS

- Fellow, American Physical Society
- CMA Stine Award, American Institute of Chemical Engineers
- Principal Investigator, National Science Foundation

PROFESSIONAL EDUCATION

- PhD, University of Illinois (1972)

Teaching

COURSES

2022-23

- Graduate Practical Training: CHEMENG 299 (Sum)

2021-22

- An Exploration of Art Materials: The Intersection of Art and Science: CHEMENG 12SC (Sum)
- Graduate Practical Training: CHEMENG 299 (Sum)
- Special Topics in Polymer Physics and Molecular Assemblies: CHEMENG 507 (Spr, Sum)

2020-21

- An Exploration of Art Materials: The Intersection of Art and Science: CHEMENG 12SC (Sum)
- Graduate Practical Training: CHEMENG 299 (Sum)
- Polymer Science and Engineering: CHEMENG 160, CHEMENG 260 (Aut)
- Special Topics in Polymer Physics and Molecular Assemblies: CHEMENG 507 (Aut, Win, Spr, Sum)
- The Chemical Engineering Profession: CHEMENG 10 (Win)

2019-20

- Graduate Practical Training: CHEMENG 299 (Sum)
- Interfacial Engineering of Soft Matter: CHEMENG 460 (Aut)
- Polymer Science and Engineering: CHEMENG 160, CHEMENG 260 (Spr)
- Special Topics in Polymer Physics and Molecular Assemblies: CHEMENG 507 (Aut, Win, Spr, Sum)
- The Chemical Engineering Profession: CHEMENG 10 (Aut)

STANFORD ADVISEES

Master's Program Advisor

Mason Hermann, Thabata Maciel, AJ Rodriguez, Alex Young

Publications

PUBLICATIONS

- **Influence of Mixed Imide Composition and Thermal Annealing on Ionic Liquid Uptake and Conductivity of Polyimide-Poly(ethylene glycol) Segmented Block Copolymer Membranes.** *Molecules (Basel, Switzerland)*
Ciftcioglu, G. A., Frank, C. W.
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- **Surface Characteristics of Poly(Alkyl Methacrylate)s from Molecular Dynamics Simulations Using All-Atom Force Field.** *Macromolecular rapid communications*
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- **Effect of Increased Ionic Liquid Uptake via Thermal Annealing on Mechanical Properties of Polyimide-Poly(ethylene glycol) Segmented Block Copolymer Membranes.** *Molecules (Basel, Switzerland)*
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- **A General Approach for Monolayer Adsorption of High Weight Loadings of Uniform Nanocrystals on Oxide Supports.** *Angewandte Chemie (International ed. in English)*
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2021
- **Structure-property relations of amphiphilic poly(furfuryl glycidyl ether)-block-poly(ethylene glycol) macromonomers at the air-water interface** *POLYMER CHEMISTRY*

- Adatia, K. K., Holm, A., Southan, A., Frank, C. W., Tovar, G. M.
2020; 11 (35): 5659–68
- **Nanoscale Spatial Distribution of Supported Nanoparticles Controls Activity and Stability in Powder Catalysts for CO Oxidation and Photocatalytic H₂ Evolution.** *Journal of the American Chemical Society*
Holm, A., Goodman, E. D., Stenlid, J. H., Aitbekova, A., Zelaya, R., Diroll, B. T., Johnston-Peck, A. C., Kao, K. C., Frank, C. W., Pettersson, L. G., Cargnello, M.
2020; 142 (34): 14481-14494
 - **Interface Characteristics of Neat Melts and Binary Mixtures of Polyethylenes from Atomistic Molecular Dynamics Simulations.** *Polymers*
Lee, S., Frank, C. W., Yoon, D. Y.
2020; 12 (5)
 - **Nanoscale Spatial Distribution of Supported Nanoparticles Controls Activity and Stability in Powder Catalysts for CO Oxidation and Photocatalytic H₂ Evolution.** *Journal of the American Chemical Society*
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 - **Polyimide-PEG Segmented Block Copolymer Membranes with High Proton Conductivity by Improving Bicontinuous Nanostructure of Ionic Liquid-Doped Films** *MACROMOLECULAR CHEMISTRY AND PHYSICS*
Woo, E., Coletta, E., Holm, A., Mun, J., Toney, M. F., Yoon, D. Y., Frank, C. W.
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 - **General Self-Assembly Method for Deposition of Graphene Oxide into Uniform Close-Packed Monolayer Films**
Holm, A., Kunz, L., Riscoe, A. R., Kao, K., Cargnello, M., Frank, C. W.
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 - **Photocatalytic CO₂ reduction using hybrid nanoporous catalysts**
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 - **Human iPSC derived progenitors bioengineered into liver organoids using an inverted colloidal crystal poly (ethylene glycol) scaffold** *BIOMATERIALS*
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2018; 182: 299–311
 - **Langmuir-Blodgett Deposition of Graphene Oxide-Identifying Marangoni Flow as a Process that Fundamentally Limits Deposition Control** *LANGMUIR*
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 - **Synthesis, characterization and light-induced spatial charge separation in Janus graphene oxide**
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 - **Langmuir-Blodgett Deposition of Graphene Oxide-Identifying Marangoni Flow as a Process that Fundamentally Limits Deposition Control.** *Langmuir : the ACS journal of surfaces and colloids*
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 - **Human iPSC derived progenitors bioengineered into liver organoids using an inverted colloidal crystal poly (ethylene glycol) scaffold.** *Biomaterials*
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- **Synthesis, Characterization, and Light-Induced Spatial Charge Separation in Janus Graphene Oxide** *CHEMISTRY OF MATERIALS*
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2017; 2 (11)
- **Interfacial and topological effects on the glass transition in free-standing polystyrene films** *JOURNAL OF CHEMICAL PHYSICS*
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2017; 116: 540-548
- **Microscopic structures in ion exchange fuel cell membranes**
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- **A Semi-Interpenetrating Network Approach for Dimensionally Stabilizing Highly-Charged Anion Exchange Membranes for Alkaline Fuel Cells** *CHEMSUSCHEM*
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- **Effects of Aromatic Regularity on the Structure and Conductivity of Polyimide-Poly(ethylene glycol) Materials Doped with Ionic Liquid** *JOURNAL OF POLYMER SCIENCE PART B-POLYMER PHYSICS*
Coletta, E., Toney, M. F., Frank, C. W.
2015; 53 (7): 509-521

- **Organocatalytic Ring-Opening Polymerization of Trimethylene Carbonate To Yield a Biodegradable Polycarbonate** *JOURNAL OF CHEMICAL EDUCATION*
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2015; 92 (4): 708-713
- **Influences of liquid electrolyte and polyimide identity on the structure and conductivity of polyimide-poly(ethylene glycol) materials** *JOURNAL OF APPLIED POLYMER SCIENCE*
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- **Phosphatidylinositol 4,5-Bisphosphate Is an HCV NSSA Ligand and Mediates Replication of the Viral Genome.** *Gastroenterology*
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2015; 148 (3): 616-625
- **A Simple Method for Encapsulating Single Cells in Alginate Microspheres Allows for Direct PCR and Whole Genome Amplification** *PLOS ONE*
Bigdeli, S., Dettloff, R. O., Frank, C. W., Davis, R. W., Crosby, L. D.
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- **Interpenetrating polymer network hydrogel scaffolds for artificial cornea periphery.** *Journal of materials science. Materials in medicine*
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2015; 26 (2): 107-?
- **Interpenetrating polymer network hydrogel scaffolds for artificial cornea periphery.** *Journal of materials science. Materials in medicine*
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- **Supramolecular motifs in dynamic covalent PEG-hemiaminal organogels.** *Nature communications*
Fox, C. H., Ter Hurne, G. M., Wojtecki, R. J., Jones, G. O., Horn, H. W., Meijer, E. W., Frank, C. W., Hedrick, J. L., García, J. M.
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- **Modular composite hydrogels from cholesterol-functionalized polycarbonates for antimicrobial applications** *JOURNAL OF MATERIALS CHEMISTRY B*
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- **Impacts of polymer-polymer interactions and interfaces on the structure and conductivity of PEG-containing polyimides doped with ionic liquid** *POLYMER*
Coletta, E., Toney, M. Y., Frank, C. W.
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- **Comparison of anhydrous and monohydrated forms of orotic acid as crystal nucleating agents for poly(3-hydroxybutyrate-co-3-hydroxyvalerate)** *POLYMER*
Tsui, A., Frank, C. W.
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2014; 54 (11): 2683-2695
- **Facilitating hydroxide transport in anion exchange membranes via hydrophilic grafts** *JOURNAL OF MATERIALS CHEMISTRY A*
He, S. S., Frank, C. W.

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- **Impact of Processing Temperature and Composition on Foaming of Biodegradable Poly(hydroxyalkanoate) Blends** *INDUSTRIAL & ENGINEERING CHEMISTRY RESEARCH*
Tsui, A., Frank, C. W.
2014; 53 (41): 15896-15908
- **Small-angle X-ray scattering of self-assembled hydrogels in topologically constrained systems**
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AMER CHEMICAL SOC.2014
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Lee, W., Frank, C. W., Park, J.
2014; 26 (29): 4936-4940
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Frank, C.
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Tsui, A., Hu, X., Kaplan, D. L., Frank, C. W.
AMER CHEMICAL SOC.2013: 251-279
- **Characterizing the effects of ambient aging on the mechanical and physical properties of two commercially available bacterial thermoplastics** *3rd International Conference on Biodegradable and Biobased Polymers (BIOPOL)*
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- **Extruded foams from microbial poly(3-hydroxybutyrate-co-3-hydroxyvalerate) and its blends with cellulose acetate butyrate** *POLYMER ENGINEERING AND SCIENCE*
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Srubar, W. V., Frank, C. W., Billington, S. L.
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- **Meso-ordered soft hydrogels** *SOFT MATTER*
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