

MIT ESI Plastics and the Environment Program (ESI-PEP)

Program summary for Supporting Members:

As part of its Sustainable Production and Consumption domain area, the MIT [Environmental Solutions Initiative](#) (ESI) has launched a campus-wide program to address the challenges of the impact of plastics on our environment. This program includes:

- Research, Education and Convening activities;
- Participation by a broad cross-section of MIT faculty;
- Collaborative projects with a wide range of partner institutions;
- Opportunities for undergraduate and graduate students;
- A broad cross-section of Supporting Members: for-profit corporations, trade associations, foundations, government agencies, consultants and individuals;
- Networking among the ESI-PEP Supporting Members and between them and the MIT community.

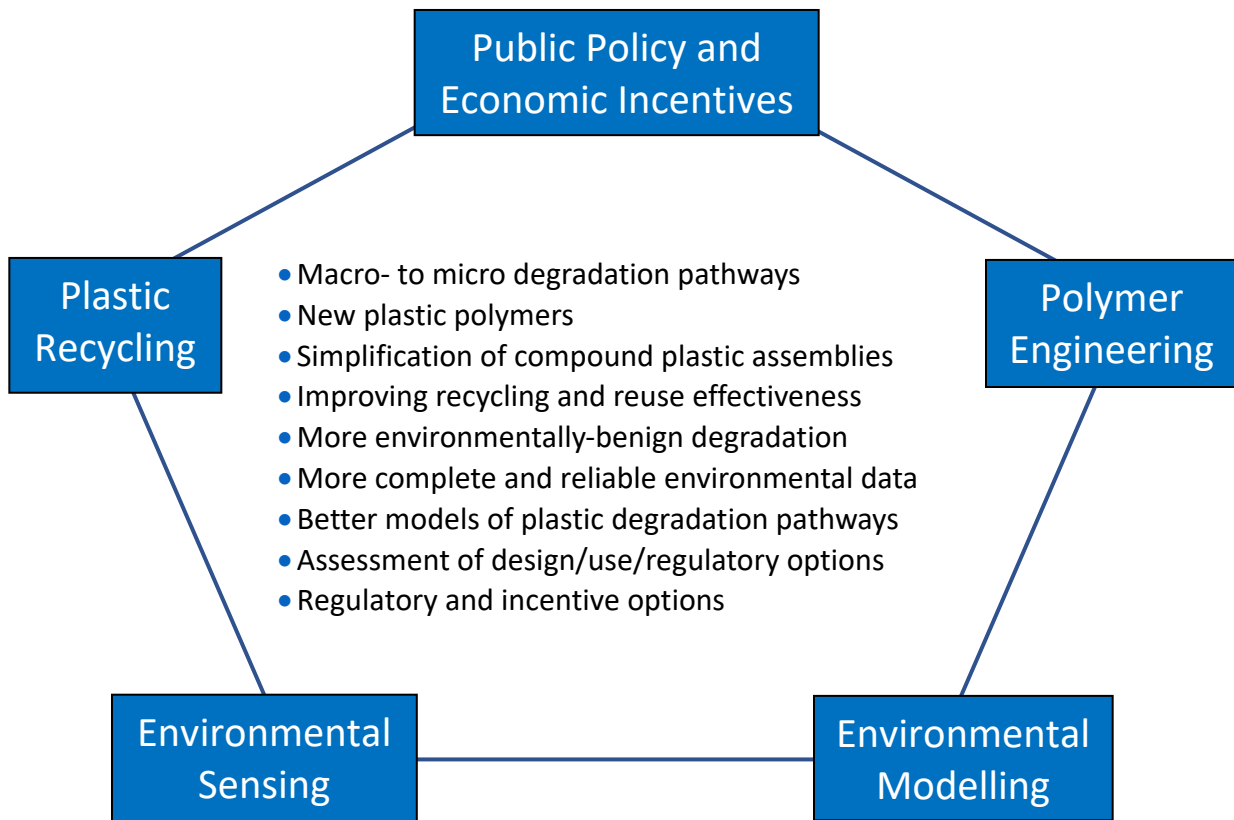
Emphasis on Research, Education, and Engagement:

The agenda for ESI-PEP includes all three activity themes of MIT ESI:

1. **Research:** projects are chosen by the ESI-PEP Faculty Council, with inputs from the Supporting Members. *Industrial sponsorship with commercial IP-licensing rights are available for appropriate research topics.*
2. **Education:** An important priority for ESI-PEP is our impact on the MIT curriculum and the involvement of undergraduate students through class projects, Undergraduate Research Opportunities ([UROP](#)), the MIT Independent Activity Period ([IAP](#)), etc.
3. **Engagement:** ESI-PEP conducts regular workshops and other events to bring together MIT and outside communities around our agenda and its broader issues: science, technology, public policy, social impact, collaboration between the public and private sectors.

Multi-disciplinary and systemic agenda:

ESI-PEP is organized around five distinct research areas which are highly inter-dependent and address questions of science, engineering, public policy, corporate and consumer behavior:



Through a collaboration with the MIT Center for Environmental Health Sciences, we are now exploring a sixth research area, **the Biologic Impact of Plastics**, which will seek to better quantify the effects of macro and microplastics on human health and ecological systems. As better information in this area is essential to guiding effective public action on plastic pollution, we aim to fund and engage faculty on active research in 2020.

Engagement events and workshops:

ESI-PEP began with a 1-day workshop in January 2018 that brought together 80+ faculty, students, researchers from industry and government agencies, policy-makers and other domain experts to discuss the current state of knowledge and activity concerning plastics in the environment, with a focus on microplastics.



Breakout session at ESI-PEP launch workshop



Plenary session at ESI-PEP launch workshop

In November 2019, we hosted a 3-day workshop, **Modelling Plastics in the Oceans**, to present new findings and exchange ideas with colleagues from the [Woods Hole Oceanographic Institution](#) and the [Worldwide Universities Network](#). Through presentations and breakout sessions, we identified new avenues for inter-disciplinary collaboration to better model the behavior of microplastics in oceans and other waterways, including opportunities to connect oceanographers and materials scientists with experts in coastal and terrestrial ecosystems.



Keynote presentation at "Modelling Plastics in the Oceans"



Audience discussion at "Modelling Plastics in the Oceans"

ESI-PEP's next workshop, **Plastics and the Environment: Science meets Public Policy**, will be held in June 2020. With a focus on public policy and economic incentives, we will aim to draw new connections between MIT's plastics research and the needs of policymakers and public officials, helping us further refine our research agenda's value and maximize the real-world impact of the ESI-PEP program.

Current Research Projects:



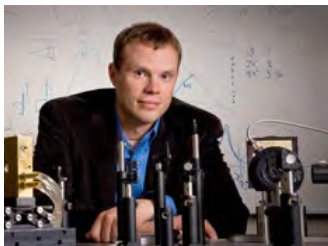
High-throughput degradation analysis: [Prof. Desirée Plata](#) is designing a lab environment for rapidly testing the breakdown of extensive variations of polymers under real-world conditions of temperature, pressure, light exposure and physical shear, in order to predict how new polymer designs will impact the lifecycle of a plastic product in the environment. The system provides a model for designing polymers with their environmental characteristics as a first-order priority before product engineering and production.



Synthesis of degradable polymers: [Prof. Jeremiah Johnson](#) is reengineering a synthesis method called “ring-opening metathesis polymerization” to eliminate highly durable carbon-carbon bonds, resulting in polymers that more readily break down in the environment, including inside the body. The resulting polymers are especially promising for medical applications.



Recyclable plastic fibers: [Prof. Julia Ortony](#) is synthesizing new variations on the polymers used to make fabrics, which are known for shedding non-degradable microfibers during everyday use. Her lab is developing a fibrous polymer that can shear to the nanoscale without loss of structural integrity, making it truly recyclable rather than merely “down-cyclable.”



Simplifying packaging through degradation-recycling: [Prof. Brad Olsen](#) is developing novel plastic packaging materials that consists of combinations of biodegradable plastics and a single recyclable thermoplastic. The combination provides suitable product use properties, and can be efficiently disposed of through a biologic degradation step followed by a single-species recycling step.



Multi-functional single-plastic fabrics: [Dr. Svetlana Boriskina](#) is developing polyethylene (PE) fabrics as a sustainable high-performance alternative to common mixed-species and coated synthetic textiles. High-value products made from PE, engineered for passive cooling, heating, structural color and anti-bacterial protection, are also efficiently recyclable.

Current Research Projects (cont'd):



3D+Time modelling of dispersion, degradation and biological interactions in aquatic environments: Profs. [Glenn Flierl](#), [Pierre Lermusiaux](#) and [Tom Peacock](#) are applying and enhancing 3D+T models of estuary and ocean flows to gain insights into the movement and fate of plastics in the oceans. It is apparent that river-borne and ocean plastics are more isolated than conventionally thought, and that turbulence and movements in the vertical plane have a significant effect on

accumulation and degradation in various aquatic environments.



Bioprocess for closed-loop PET (polyethylene) recycling: Profs. [Anthony Sinskey](#) and [Gregory Stephanopoulos](#) are engineering Polyethylene Terephthalate (PET)-degrading enzymes, as current enzymes are too slow for economically-feasible biological processes. As part of this project, they are developing a high-throughput purification and PET-degradation detection

method to screen large families of enzymes, and new assays to monitor the degradation process continuously and to determine how the enzymes interact with the PET surface.



Microfiber filtering technology for laundry water: [Prof. Jeff Grossman](#) is developing silicon filtration membranes engineered for filtering microfibers out of laundry water, a major source of microfiber propagation into waterways. Existing technology is not able to capture fine-scale microfibers without clogging on the macro-particles that are also present in the effluent.

Partner Institutions:

Collaborative research is an essential aspect of our agenda. Current partner institutions include:

- [Wood Hole Oceanographic Institution \(WHOI\)](#) and [WHOI Microplastics in the Ocean](#)
- [Conservation International](#)
- [Rozalia Project](#)
- [Worldwide Universities Network](#)

Supporting Member Participation and Benefits:

Supporting membership in ESI-PEP is available to interested organizations and individuals. Membership is through annual renewable gift contributions. Benefits include:

- Regular updates and reports on progress and results of ESI-PEP research projects;
- Opportunities to influence ESI-PEP research agenda and priorities;
- Facilitated introductions to faculty researchers and faculty;
- Engagement opportunities with ESI-PEP graduate students and student-run organizations for internship and employment recruitment;
- Video and face-face ESI-PEP symposia presenting the leading edge of MIT thinking on challenges and solutions to environmental issues;
- Networking opportunities with other Supporting Members and the MIT community;
- Targeted opportunities for Supporting Member commercial companies to sponsor individual ESI-PEP projects with MIT IP commercial licensing rights.

Joining ESI-PEP as a Supporting Member:

For more information, please contact:

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