Chemists create faster-degrading plastic for marine uses

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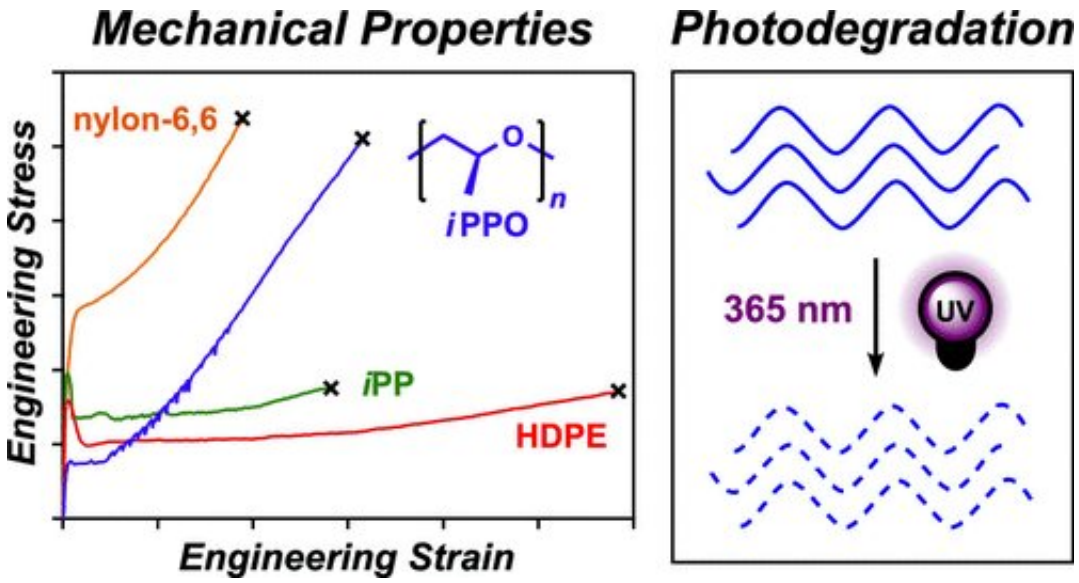

Credit: ACS

To address the plastic environmental crisis, Cornell chemists have developed a new polymer with ample strength in a marine setting that is poised to degrade by ultraviolet radiation, according to research published March 30 in the *Journal of the American Chemical Society*.

"We have created a new plastic that has the mechanical properties required by commercial fishing gear. If it eventually gets lost in the aquatic environment, this material can degrade on a realistic time scale," said lead researcher Bryce Lipinski, a doctoral candidate in the

laboratory of Geoff Coates, the Tisch University Professor in the Department of Chemistry and Chemical Biology, in the College of Arts and Sciences. "This material could reduce persistent plastic accumulation in the environment."

Commercial fishing contributes to about half of all floating plastic waste that ends up in the oceans, Lipinski said. Fishing nets and ropes are primarily made from three kinds of polymers: isotactic polypropylene, high-density polyethylene, and nylon-6,6, none of which readily degrade.

"While research of degradable plastics has received much attention in recent years," he said, "obtaining a material with the mechanical strength comparable to commercial plastic remains a difficult challenge."

Coates and his research team have spent the past 15 years developing this plastic called isotactic polypropylene oxide, or iPPO. While its original discovery was in 1949, the mechanical strength and photodegradation of this material was unknown before this recent work. The high isotacticity (enchainment regularity) and polymer chain length of their material makes it distinct from its historic predecessor and provides its mechanical strength.

Lipinski noted that while iPPO is stable in ordinary use, it eventually breaks down when exposed to UV light. The change in the plastic's composition is evident in the laboratory, but "visually, it may not appear to have changed much during the process," he said.

The rate of degradation is light intensity-dependent, but under their laboratory conditions, he said, the polymer chain lengths degraded to a quarter of their original length after 30 days of exposure.

Ultimately, Lipinski and other scientists want to leave no trace of the polymer in the environment. He notes there is literature precedent for

the biodegradation of small chains of iPPO which could effectively make it disappear, but ongoing efforts aim to prove this.

Joining Lipinski and Coates on the paper, "Isotactic Poly(propylene oxide): A Photodegradable Polymer with Strain Hardening Properties," were Lilliana S. Morris, Ph.D. '19, assistant professor of chemistry at the College of Wooster, Ohio; and Meredith N. Silberstein, associate professor in the Sibley School of Mechanical and Aerospace Engineering.

More information: Bryce M. Lipinski et al, Isotactic Poly(propylene oxide): A Photodegradable Polymer with Strain Hardening Properties, *Journal of the American Chemical Society* (2020). DOI: 10.1021/jacs.0c01768

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