Photodegradable Polymers Enable Recovery of High Value Components from Electronics and Composites (RFT-477, RFT-529)

Invention Summary

In the U.S., only about 10% of post-consumer plastic is recycled. This leads to incredible waste of both plastic and valuable materials embedded in plastic. NDSU researchers have developed a photodedgradable polymer technology to improve value-added recovery of materials from plastics, as well as recycling of the plastics themselves. Recovery of valuable components represents a huge and poorly tapped opportunity for reuse, with electronic devices and carbon fiber composites being two examples. With respect to carbon fiber products, more than 30% of carbon fiber ends up discarded as waste. Electronics have an even worse recycling story. Almost 90% of electronic waste is disposed without recycling, even though it is a gold mine … one ton of circuit boards contains 40 – 800 times more gold than a ton of ore. There is also a tremendous amount of copper, silver, and palladium that is discarded rather than recovered. One way to radically decrease this waste is to make recovery and sorting of the valuable components easier and less expensive. The NDSU technology enables this recovery, using polymers (optionally bio-based) with built-in photocleavable unit(s). The resulting photodegradable polymers can be designed for degradation with specific wavelengths of UV and/or visible light by selecting the appropriate photocleavable unit(s). Use of these photodegradable polymers in circuit boards and in carbon fiber composites would enable them to be recycled far easier than today. They could be collected, exposed to the specific wavelength needed to degrade the ‘plastic’ structural or connecting material(s), which releases the high value metals and carbon fiber for collection, recycling, and reuse. Additionally, the photodegraded remnants of the polymers can themselves be collected and used to produce a new plastic product.

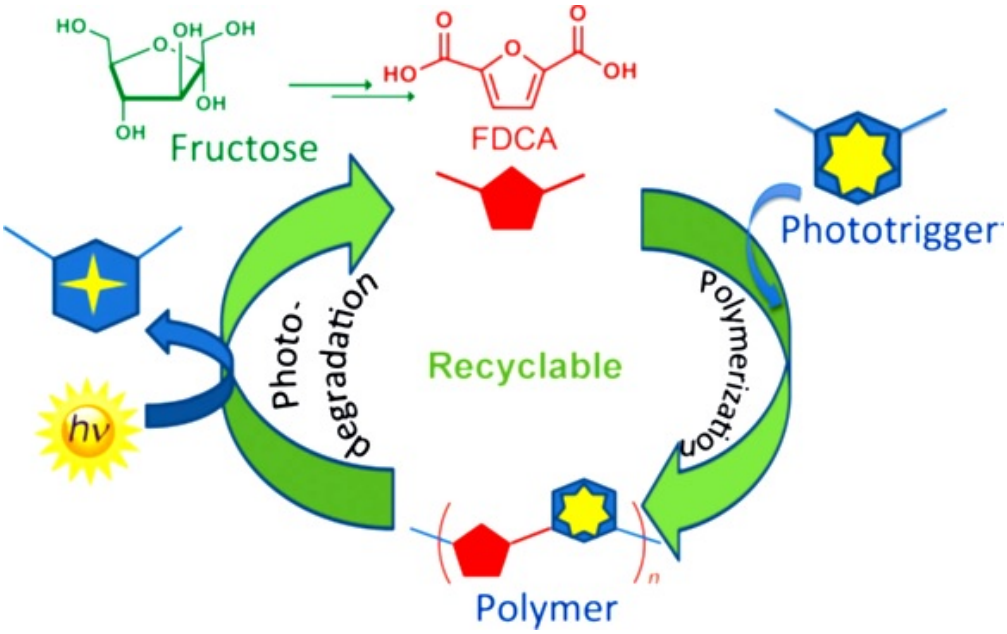

Figure 1: Concept of programmed photodegradation of bio-based oligomers/polymers derived from FDCA featuring a nitrobenzyl chromophore to trigger photo-degradation upon (in this case) UV irradiation*

*Rajendran, S., Raghunathan, R., Hevus, I., Krishnan, R., Ugrinov, A., Sibi, M. P., Webster, D. C. and Sivaguru, J. (2015), Programmed Photodegradation of Polymeric/Oligomeric Materials Derived from Renewable Bioresources. Angew. Chem., 127: 1175–1179. doi: 10.1002/ange.201408492

Benefits

- Produce plastic backing / structural material that enables efficient and cost-effective recovery and recycling of high value metals and carbon fibers from e-waste and composites respectively
- Tunable as to wavelength that triggers photodegradation, with anticipated range between 300 nm and 850 nm
- Can use multiple phototriggers, for example in block copolymers, that enable customized breakdown process / intermediates
- Tunable breakdown process, which can be impacted based on light intensity, structure of the materials, and the amount of phototrigger that was incorporated into the polymers
- Suitable for colored plastics, as long as the color differs from the wavelength needed for photodegradation
- Monomers are derived from biomass, reducing carbon footprint as compared with petroleum-based polymers, and can themselves be recycled
- The technology is generally applicable to improving recycling of plastics, whether or not they

include value added materials that can also be recovered

Patents

This technology is the subject of issued US Patent No. 9,738,753 and is available for licensing/partnering opportunities.

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