University of Crete
Department of Physics

Physics Colloquium

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The Plastic Crisis: A Chemistry Perspective

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ABSTRACT

During the last decade, plastic pollution has emerged as one of the most serious threats to humanity and our planet. Plastic waste is ubiquitous in the air, soil, freshwater, and the sea. Besides plastic bans and taxes, two main approaches have been proposed to address the current unsustainable consumption pattern: polymer recycling and biodegradable alternatives, both with certain pros and cons.

Stimuli-degradable polymers possess important advantages in polymer waste management allowing the on-demand main-chain polymer degradation using certain external stimuli. Among the different triggers proposed to cleave the polymer bonds, light has emerged as a particularly attractive stimulus to induce a photo-mediated main chain polymer degradation, because of its tunable intensity and wavelength and noninvasive nature [1]. In this talk, we will discuss two novel, main-chain, stimuli-degradable polymer families as proof-of-concept studies to improve polymer sustainability. First, soft, transparent, photodegradable, and thermo-reversible polymer gels, comprising PEG as the elastic strands, that undergo degradation upon exposure to light, will be presented [2]. Mechanistic studies revealed a chemical recycling process to obtain the initial reagents as the main photoproducts, enlightening the mechanism of network reformation upon heating the system at mild temperatures, as verified by shear rheology experiments. The hydrogels successfully underwent reversible photodegradation and reformation upon heating, restoring the initial mechanical properties of the polymer network and thus revealing the re-processability of the system. In the second part, photo- and acid-degradable poly(acylhydrazones) synthesized via a step-growth reaction of dicarbonyl and diacylhydrazide comonomers is presented [3]. The photo-sensitivity of the synthesized polymers to light was verified by irradiation studies in aqueous solution, while a mechanistic study shed light on the photodegradation mechanism and the produced photoproducts.

References

1. T. Chen H. Wang, Y. Chu, C. Boyer, J. Liu, J. Xu, *ChemPhotoChem* **2019,** *3,* 1059; G. Pasparakis, Th. Manouras, M. Vamvakaki and P. Argitis *Macromol. Rapid Commun.* **2012**, *33*, 183; *Angew. Chem. Int. Ed.* **2011,** *50,* 4142-4145; *Nat. Commun.* **2014,** *5,* 3623.
2. M. Psarrou I. Chatzaki, A. Mavromanolakis, D. Vlassopoulos and M. Vamvakaki **2024,** submitted.
3. M. Psarrou, M. G. Kothri and M. Vamvakaki, *Polymers* **2021,** *13,* 2461. M. Psarrou and M. Vamvakaki, *Europ. Polym. J.* **2024,** *210,* 112929.