Circular use of landfill and domestic waste towards functional hybrid materials

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This study investigates the use of landfill and domestic waste as raw materials for the synthesis of hybrid polymers with potential applications in fields ranging from energy storage to biomedicine, hence enabling a circular economy. This project is designed to apply the existing interdisciplinary knowledge on sustainable polymer chemistry[1-2] at IS2M along to contribute to the Cross-border Sustainability Research activities in the Upper Rhine region.

Nowadays, the petrochemical derived polymers have created a lot of waste that also enters the environment creating major environmental problems. Hence, there is an urgent need that polymer chemists adjust their focus on prime resources and incorporate waste (landfill and domestic) as valuable starting material to produce new polymers as alternatives to the existing conventional ones. So, it is postulated to use the following waste derivatives as green raw materials for the production of novel hybrid polymers (Figure 1): (i) Waste cooking oils (WCOs) and (ii) egg-shell waste (ESW, an ordered bioceramic composite, which is mainly composed of calcium carbonate and diverse proteins) as the most abundant waste materials coming from food processing technologies; in addition to elemental sulfur (S8, the main-product of the hydrodesulfurization of petroleum industry). While those derivatives have been separately used to design novel polymeric materials with improved thermal, mechanical and degradation properties, the utilization of synthetic methods which are based on using the three waste materials in one pot reactions is not elaborated. Thus, it is aimed to explore synthetic opportunities which can facilitate the incorporation of ESW, S8 and WCOl as components (such as monomers, catalysts) in polymer formulations. Inverse vulcanization (the bulk free radical polymerization of unsaturated co-monomers (i.e., crosslinkers) in molten S8) will be explored at first glance as a suitable approach. Accordingly, hybrid polymers with different compositions based on S8, WCO (as the crosslinker) and ESW (as the catalyst and filler) will be explored to fine tune the thermal, mechanical, optical properties towards diverse applications ranging from energy storage and heavy metal remediation to antibacterial surfaces. It is anticipated that the novel hybrid polymers will combine excellence properties such self-healing along chemical recyclability (due to the polysulfide bonds introduced from S8), therapeutic (resulting from ESW) in addition to biodegradability (resulting from the WCO) amongst others.

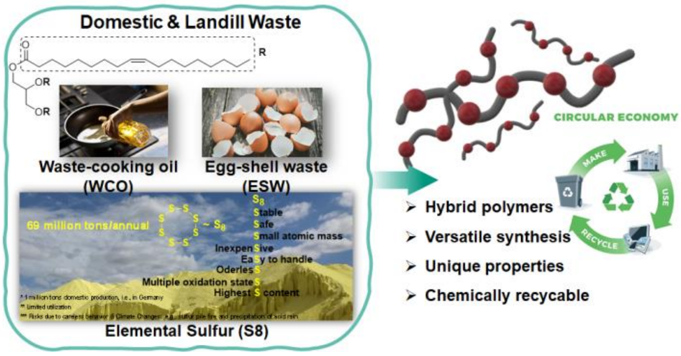

Figure 1. A pathway to ensure circular economy by using waste (domestic and landfill) as valuable starting material to produce new polymeric materials as alternatives to the existing conventional polymers.

[1] M. E. Duarte, B. Huber, P. Theato, **H. Mutlu**, Polymer Chemistry **11**, 241 (2020).

[2] **H.Mutlu**, *PhD. Thesis: Sustainable, efficient approaches to renewable platform chemicals and polymers*