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Polymer functionality by degradation: the activation of mechanophores in a ball mill

Mechanical stress leads to cracks and failures in materials and can also induce bond scission and the formation of radical species. Just as a UV lamp can accelerate photo-aging, mechanical stress applied via ball milling (or in another way) can be used to speed up material degradation and simulate mechanical wear over time.
Additives, especially antioxidants, are commonly added to polymers and it has already been studied how the properties of materials change in their presence and how they interact with the material to slow down the degradation process. In this study BHT (butylated hydroxytoluene) was chosen as antioxidant for polystyrene (PS).
When a mechanophore is included within polymer chains, they typically promote selective bond scission, but not always at the intended site, raising questions about mechanophore selectivity. This is due to the intrinsic complexity of polymers compared to small molecules, with numerous variables influencing the outcome. Therefore, it is crucial to investigate whether the presence of additives can enhance the selectivity of mechanophore-induced bond scission, in order to achieve better control over polymer degradation.

Using a combination of mechanical testing, spectroscopic analysis and GPC measurements, and comparing samples with and without BHT, this behavior is systematically studied. This will be important for steering mechanical stress to trigger functional responses with molecular precision.

Primary authors: ADDUCCHIO, Matteo (Bergische Universität Wuppertal); Prof. GÖSTL, Robert (Bergische Universität Wuppertal)

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