Mechanophore Activation at Hetero-interfaces

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Molecular design of force-sensitive molecules in polymer mechanochemistry has brought new concepts in smart materials, yet its use has been limited to homogenous polymer systems. The nature of polymer mechanochemistry at interfaces, which are arguably more important considering the prevalence of composite materials in industrial applications, remains mostly unexplored. Here we report a novel system that implements mechanophores as anchor points at hetero-interfaces. Silica nanoparticles grafted with poly(methyl acrylate) (PMA) chains anchored by a maleimide-anthracene cycloadduct were synthesized to demonstrate mechanochemically-selective activation of mechanophores at heterogeneous interfaces. By quantifying the anthracene-containing cleaved PMA polymers, which are generated via retro [4+2] cycloaddition reactions, the first order kinetic coefficient was determined. Activation characteristics of mechanophores anchored to a nanoparticle exhibit behavior similar to mechanophore-linked polymers, e.g., threshold molecular weight and linear increase in rate coefficient with molecular weight above the threshold. This model system is thus valuable as a probe to test stress activation of interfacially-bonded mechanophores and to design smart, mechanically-sensitive and self-repairing composite materials.