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Tuning mechanical properties of polymer-grafted nanoparticle networks by using biomimetic catch bonds BADEL L. MBANGA, BALAJI V. S. IYER, VICTOR V. YASHIN, ANNA C. BALAZS, Chemical Engineering Department, University of Pittsburgh, Pennsylvania 15261, USA — Cross-linked networks of polymer-grafted nanoparticles (PGNs) constitute a class of composites with tunable mechanical properties that exhibit a self-healing behavior. A PGN network consists of nanoparticles that are decorated with end-grafted polymer chains. Reactive groups on the free ends of these grafted chains can form bonds with the chain ends on the nearby particles. We study these materials using a 3D computational model that encompasses the particle-particle interactions, the kinetics of bond formation and rupture, and the external forces applied to the network. In our model, a fraction of cross-links is formed through biomimetic catch bonds. In contrast to conventional slip bonds, catch bonds can effectively become stronger under a deformation. We show that by varying the fraction of these catch bonds in the network, the toughness, ductility, and tensile strength of the material could be tuned to desired levels.

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