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Introducing Dynamic Properties to Polymer Networks Via Stimuli-Responsive Nanoparticles

Background

Polymer nanocomposites (PNCs) have gained attention in recent years in the field of nanotechnology due to their versatility for applications in nanoelectronics, bionanomaterials, sensors, sustainability, reinforced PNCs, and drug delivery systems. PNCs are typically fabricated through a variety of methods including solution dispersion, in situ polymerization, and melt extrusion. PNCs contain two main components: the polymer and the nano-fillers. Improved material properties including decreased flammability and increased conductivity can be obtained in PNCs at low concentrations of nano-fillers. However, these improved properties depend heavily on the homogeneous distribution of the nanoadditive in the polymer matrix, which is currently difficult to achieve.

Invention Description

Researchers at Arizona State University have developed a novel method of synthesizing polymer nanocomposites with enhanced mechanical properties where polymer networks are crosslinked via supramolecular bonds at the interface of nanoparticles and polymer matrix. This invention functionalizes gold nanoparticles (AuNPs) with 11-mercaptoundecanoic acids which form hydrogen bonds with poly(dimethyacryamide) (PDMA) and assemble to form a polymer network upon mixing. Steric stabilization of the surface-functionalized nanoparticles (particle-based crosslinks) as a consequence of weak polymer adsorption prevents nanoparticle aggregation during solvent exchange and leads to successful surface functionalization. The self-assembled polymer nanocomposite exhibits a glass transition temperature of 90°C and self-healing properties at a range of temperatures due to interfacial hydrogen bonds.

Potential Applications

- Biomedical (e.g., tissue engineering, drug delivery)
- Sustainability (e.g., clean energy, green transportation)
- Aerospace (e.g., sensors, defense systems)

Benefits and Advantages

- Successful surface functionalization
- Improved mechanical properties
- Increased glass transition temperature (90°C)
- Self-healing properties at a range of temperatures