Researchers develop neuron-inspired, high-performance telechelic polymer
13 July 2022, by Zhang Nannan

Researchers at the Ningbo Institute of Materials Technology and Engineering (NIMTE) of the Chinese Academy of Sciences have proposed a neuron-inspired all-around telechelic polymer with remarkable mechanical and physical properties, rapid self-healing ability, adhesion, triboelectricity, as well as aggregate induced emission (AIE) fluorescence. The results were published in Advanced Functional Materials.

High-performance polymers show tremendous application prospects in the high-tech fields of marine anti-corrosive coating, energy storage, flexible sensors and intelligent displays. However, it remains challenging to develop polymers integrated with outstanding mechanical properties (such as stiffness, toughness, crack tolerance), rapid self-healing ability, triboelectricity and even electrical or optical properties.

Inspired by the axon structure of neuron, researchers at NIMTE synthesized a telechelic polymer with a three-arm structure. The 2-ureido-4-pyrimidinone (UPy) terminates each arm and its length is well controlled within a small range to reduce the entanglement density, thus improving self-healing efficiency of the telechelic polymer. Meanwhile, extensive urea groups are embedded into each arm to construct a hierarchical hydrogen bonds (H-bonds) network.

By adjusting the length of the arm, the mechanical performance of the synthesized polymer can be tuned easily. The polymer showed excellent mechanical performance with stiffness of 97.9 MPa, strength of 22.5 MPa, elongation at break of 1,470%, toughness of 159.3 MJ m⁻³ and notch resistance of 187 kJ m⁻².

After 30 min of self-healing, the toughness of the synthesized polymer can recover to 92%, indicating outstanding rapid self-healing ability.

The extensive H-bonds endow the polymer with excellent adhesion since the lap-shear strength can reach up to 20.7 MPa when bonded with iron plates, which was the highest value reported for hot-melt adhesives.

Moreover, the telechelic polymer can be positively charged with a high open circuit voltage after friction with copper.

Under 365 nm ultraviolet light, the telechelic polymer can emit intrinsic blue fluorescence, owing to the AIE of tertiary amine groups.

The study on the neuron-inspired all-around telechelic polymer has enriched the design notion of high-performance versatile nano-materials, and shows great application potential especially in the marine fields of underwater anti-counterfeiting, underwater encapsulation and underwater adhesion.

More information: Haiming Chen et al, Neuron Inspired All?Around Universal Telechelic Polyurea with High Stiffness, Excellent Crack Tolerance,

Provided by Chinese Academy of Sciences

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