Practical Method For Synthesizing Self-Healing Polymers

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BRIEF DESCRIPTION

The invention is a design and a synthetic method that enables autonomously self-healing polymers. Unlike any previously reported self-healing substances, this material repairs itself into a single-component solid in a truly autonomous manner, without use of heat, light, any other external stimulus, healing agents, plasticizers, or solvent. The disclosed multiphasic material is prepared from inexpensive components in a facile and scalable manner. Furthermore, the mechanical properties of this elastomer can be easily tuned across a broad range (from soft rubber to hard plastic) by changing several parameters during the synthesis.

FULL DESCRIPTION

It is desirable for man-made materials to be capable of imitating nature in its ability to spontaneously heal injury, thus, increasing their survivability and lifetime. In sharp contrast, synthetics usually fail after damage or fracture. Moreover, despite significant research efforts, most self-healing materials reported to date require some kind of an external (heat or light) or internal (healing agents) stimulus. Alternatively, the ease of self-healing can be improved by relinquishing material's mechanical strength and stiffness, as in the cases of substantially solvated soft gels or plasticized rubbers. However, the synthesis of a hard material with intrinsic self-healing ability has been elusive.

Researches at UCI have now developed an inexpensive and facile strategy for obtaining materials with tunable mechanical strength that can spontaneously repair themselves upon damage. The "healing" process is completely autonomous even in ambient environment, and no heat, light, healing agents, solvent, plasticizer, or any other additives are necessary for repair activation. The material's highly advantageous properties originate from the clever design inspired by nature and rely on hydrogen-bonded brush polymers that are, in turn, self-assembled into a hard–soft microphase-separated system. The overall structure combines the enhanced stiffness and toughness of nanocomposites with the self-healing capability of soft dynamic supramolecular assemblies. In addition, the proposed approach offers versatility in tuning the structures and properties of the substance, allowing for a wide range of mechanical properties.

The current invention is a follow-up to a previously reported method that relied on custom-made building blocks. The researchers have now shown that their design and synthesis approach can be extended to include very simple commercially available starting materials and still allow both excellent auto-healing capabilities and control over mechanical strength of the material. Overall, the current invention is a cheap, practical, and scalable synthetic method that provides access to a broad range of self-healing polymers with tunable mechanical properties.

SUGGESTED USES

This invention holds great promise for improving the safety, lifetime, energy efficiency, and environmental impact of man-made materials.

ADVANTAGES

CONTACT

Richard Y. Tun
tunr@uci.edu
tel: 949-824-3586.

OTHER INFORMATION

KEYWORDS

Polymers, Self-healing polymers, Hydrogen bonding, Multiphase materials, Thermoplastic elastomers, Acrylamide copolymers

CATEGORIZED AS

- Materials & Chemicals
  - Chemicals
  - Polymers

RELATED CASES

2015-870-0, 2011-880-0

The current synthetic method is simple, inexpensive, and scalable. At the same time, it allows tuning of mechanical properties of the final material through a few straightforward adjustments to the production method.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,111,330	09/07/2021	2015-870
United States Of America	Issued Patent	9,938,368	04/10/2018	2011-880
United States Of America	Published Application	20220041782	02/10/2022	2015-870

STATE OF DEVELOPMENT

Able to produce kilogram scale of material. Self-healing ability at mild conditions demonstrated in the lab.

RELATED MATERIALS

» Yulin Chen, Aaron M. Kushner, Gregory A. Williams, Zhibin Guan Multiphase design of autonomic self-healing thermoplastic elastomers. Published in NATURE CHEMISTRY, VOL 4, JUNE 2012

RELATED TECHNOLOGIES

- Self-Healing Elastomers

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5270 California Avenue / Irvine,CA 92697-7700 / Tel: 949.824.2683