

Bio-based Non-isocyanate Polyureas (NIPUrea): Covalent Adaptative Network CAN materials with Shape Memory properties

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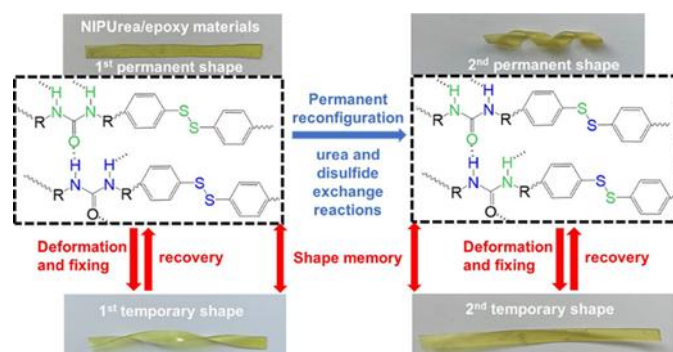
Résumé :

Thermosetting polymers are renowned for their excellent thermomechanical properties, environmental stability, and resistance to chemicals and solvents. However, their chemically cross-linked nature often limits the ability to undergo complex permanent shape changes [1]. In addition, due to non-renewable resources, the environmental impact is a major concern [2]. This study introduced a novel bio-based non-isocyanate polyurea (NIPUrea) material that addresses these limitations by incorporating bio-based components and dynamic disulfide bonds to develop covalent adaptative network materials.

The primary objective of this research was to explore and characterize NIPUrea materials that not only exhibit shape memory effects but also allow for permanent shape reconfiguration through thermal stimuli. The material was synthesized from bio-based amino-terminated polyureas (NIPUrea) with bio-based epoxy cross-linkers, and 4,4'-Diaminodiphenyl sulfide (DADS). DADS served as a source of dynamic disulfide bonds, which are crucial for facilitating topological rearrangement of the cross-linked network structure upon thermal stimulation. The study aimed to fine-tune the cross-link density and reversible bond content in the polymer network to optimize the ensuing shape memory and mechanical properties.

Through a series of carefully designed experiments involving varying chemical compositions, we successfully fine-tuned the cross-link density and, importantly, the content of reversible bonds in the polymer network.

Our findings underscored the pivotal role of reversible bonds in achieving excellent shape memory and mechanical properties. The study confirmed that these modifications do not adversely affect essential material properties such as thermal stability and mechanical strength, offering a sustainable alternative to conventional thermoset polymers [3,4]. These materials have therefore a wide range of potential applications, including in aerospace, smart actuators, and sensors, due to their outstanding shape memory properties and ability for permanent reconfiguration. The bio-based nature also offers a more sustainable alternative to traditional thermosetting materials.



Schematic diagram of dynamic network exchange and shape- memory properties [3]

Références :

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