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Self-Healing Material Design and Optimization for Soft Robotic Applications †

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Abstract: The Diels-Alder reaction between furan and maleimide is the most studied example of reversible covalent chemistries for creating self-healing materials. While scientific articles reporting the synthesis of new reversible polymer networks are numerous, accurate knowledge of the reaction kinetics and thermodynamics of the dynamically reversible equilibrium reaction and the structure and property development of derived stimuli-responsive materials are less widespread. The requirements for the material properties and behavior become more stringent when designing materials for dedicated applications, such as soft robotic structures. Optima need to be sought between reasonably fast reaction kinetics for fast and efficient damage healing at moderate temperatures and mechanical strength and structural stability on the other hand. Stress relaxation is desired to make materials tougher, relieving stress before defects can grow into cracks and ultimately lead to failure, while creep can't be allowed. Recycling and reprocessing of materials are desirable from an ecological viewpoint, while the materials should also be able to withstand static and dynamic loading in a considerable range of environmental conditions. Accurate knowledge of the reaction kinetics and thermodynamics and an in-depth knowledge of structure-processing-property relations allow smart polymer network design with tailored stimuli-responsive behavior and use as self-healing materials for robotic applications.

Keywords: dynamic covalent networks; self-healing materials; soft robotic actuators.

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Conflicts of Interest

The authors declare no conflict of interest.