Mechanosensitive polymers for optical signalling of overloads in personal protective equipment

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Abstract

There is a demand for practical and reliable warning mechanism for material fatigue and signs of overloading of personal protective equipment. Novel functional polymers have been developed that undergo controlled intramolecular rearrangements under the influence of mechanical forces, called mechanophores. These molecules can be coupled with a fluorescent dye that is activated when the polymer is subjected to mechanical stress.
The project FrüLing exploits this principle for providing textiles with a new type of functionality for indicating destructive mechanical forces (overloads and wear) by integrating such polymers.

First, functional polymers with mechanophores as central units were designed and synthesized that release umbelliferron as a fluorescent dye when subject to mechanical forces. Acrylate-based monomers with poly ethylene glycol side chains were used to enable waterborne formulations. The degree of polymerization and the side-chain length were varied to adjust the water solubility of the polymers and the viscosity of the formulations. Model studies using these polymers were conducted to establish structure-property relationships (force response) and identify the polymer architecture that yields the highest release of fluorophore. In a second step, formulations were used for surface coating of Poly(ethylene) and Poly(ethylene terephthalat) films to probe the activation of the mechanophore by mechanical force. Absolute force as well as strain was probed to establish suitable molecular parameters for the application in protective equipment.

Keywords: Functional polymer coating, Mechanophore

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