Towards Mechanochromic Materials Based on Non-Covalent Interactions

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Abstract

Materials found in nature have unique properties that remain challenging to replicate artificially. Thus, mechanosensory neurons or color changing chromatophores can translate mechanical stimuli into a materials response.[1] The development of mechanoresponsive materials is inspired by such examples and several chemical motifs, referred to as "mechanophores" have been identified that respond to mechanical activation through the scission of covalent bonds.[2] More recently, non-covalent interactions have been considered as potentially useful mechanoresponsive moieties that offer dynamic interactions, tunable interaction strengths, and a reversible process as additional benefits.[3] In this context, we aim to exploit supramolecular interactions to prepare materials which, upon mechanical activation, exhibit a macroscopic response such as a change of color.

Here we present the preparation of supramolecular polymers that relies on the reversible coordination to naphthalimide-based chromophores with conjugated thiourea moieties as the binding motif (Figure 1). The versatile nature of the latter allowed for the coordination of anions such as carboxylates or bases such as amines.[4,5] In both cases, the formation of the coordination complex was found to induce charges into the conjugated chromophores and resulted in a substantial red-shift of their absorption. In the solid state, the complex formation of the prepared chromophores with carboxylate-based polymers was hampered by the competing counter ions. By contrast, amine-based polymers coordinated to the chromophores and supramolecular polymers were successfully obtained in solution as well as in the solid state. The response of these materials to mechanical stimuli is the subject of our investigations and chromogenic effects may act as an internal probe that facilitates the detection and analysis of wear.

References

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Figures

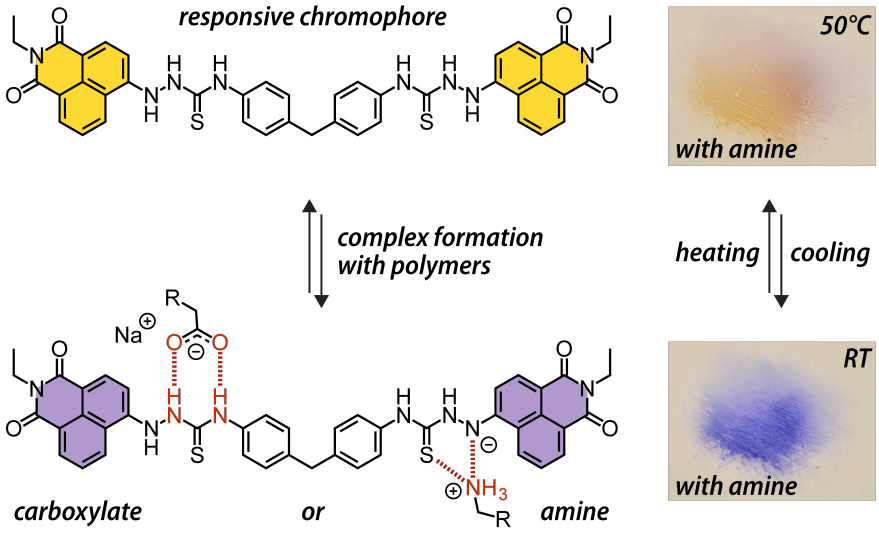

Figure 1: The thiourea-based naphthalimide chromophore can be activated through hydrogen bonding with carboxylates or through ionic interactions with amines. On this basis, the preparation of responsive supramolecular polymer films is investigated.