LIGHT-STABILISED DYNAMIC MATERIALS
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ABSTRACT
The ability of photoswitches to efficiently and reversibly undergo a photochemical response continues to highly impact the field of materials science, most notably in the design of molecular machines that can undergo translational or rotary motion that is fuelled by light.1,2 Yet, existing photoswitches are exclusively based on photo-induced intramolecular transformations such as isomerisation and cyclisation processes. In other words, no constitutional dynamic behaviour in the sense of bimolecular covalent bonding or debonding can be directly established by the applied trigger.

Motivated to devise a material that can undergo a repeatable change in topology from a covalently crosslinked material to a liquid polymer formulation, simply by switching one colour of light on-and-off without the need for any additional triggers, we here introduce an unprecedented concept in the field of light-switchable materials. Specifically, the visible light-driven cycloaddition reaction of triazolinediones (TADs) with naphthalenes was exploited as a suitable dynamic covalent crosslinking system because the photostationary state is almost quantitatively populated by the cycloadduct, whereas the resulting photoproducts readily dissociate upon standing in the dark. Following model investigations of this unique feature, the TAD-naphthalene-based polymer materials were developed and the light-switchable states of matter were characterised by means of rheology. Critically, the mechanical integrity of the polymer materials is retained as long as the green light is kept switched on, which was also evidenced by macroscopic demonstrations. The observed extraordinary behaviour of the TAD-naphthalene-based networks lead us to pioneer the concept of light-stabilised dynamic materials.

References:
1Feringa, B.L.; Angew. Chem., Int. Ed. 2017, 56, 11060-11078.