Group	:	Responsive Supramolecular Polymers
Project	:	**Tunable dynamic polymers**
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Introduction

The incorporation of reversible bonds in covalent polymers networks has allowed polymer materials to become responsive and environmentally adaptive, leading to 'smart' materials that are for example self-healing or malleable. Next to non-covalent bonds, more recently also dynamic covalent bonds have been employed to prepare such smart polymer materials, as this type of bond combines reversibility with the robustness of covalent bonds.
However, in comparison to purely covalently linked polymers or to supramolecular polymers, the field of dynamic covalent polymers is still underexplored. A limitation in the development of dynamic polymer materials is that the relations between molecular properties and macroscopic, dynamic material properties are often not fully understood. As a result, current dynamic covalent materials display non-optimal mechanical properties, such as creep or the need for elevated temperatures to function.

To enable a more rational synthesis of structurally dynamic (polymeric) materials, in this project a systematic design approach is pursued in which the bulk polymer properties can be fine-tuned by control over the small-molecule kinetics of the dynamic covalent motifs present in the polymer material. To this end we will synthesize a set of so-called Tunable Dynamic Motifs (TDMs), based on the dynamic covalent imine bond, whose exchange kinetics can be tuned – over multiple orders of magnitude– by control over the electronegativity of the substituents. By incorporation of these TDMs in covalent polymer networks a 'handle' is introduced into the polymer network that can be used to control the exchange rates and corresponding relaxation rate, thus offering control over the macroscopic material properties by systematic small-molecule variation (figure 1).

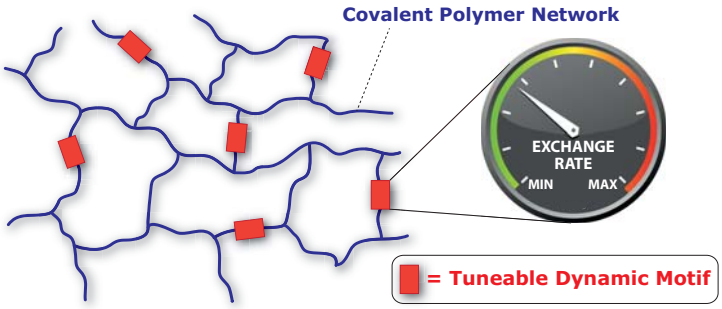

Figure 1. *Schematic representation of a polymer network incorporating the proposed Tunable Dynamic Motifs.*

Based on these studies, it will be possible to rationally design polymer materials with specific, pre-determined properties in a bottom-up fashion. As a proof of concept two types of functional dynamic polymer materials will be developed: firstly a room-temperature, autonomously self-healing polymer, and secondly a recyclable thermoset polymer will be synthesized. The general polymer network synthesis scheme is given below in figure 2.

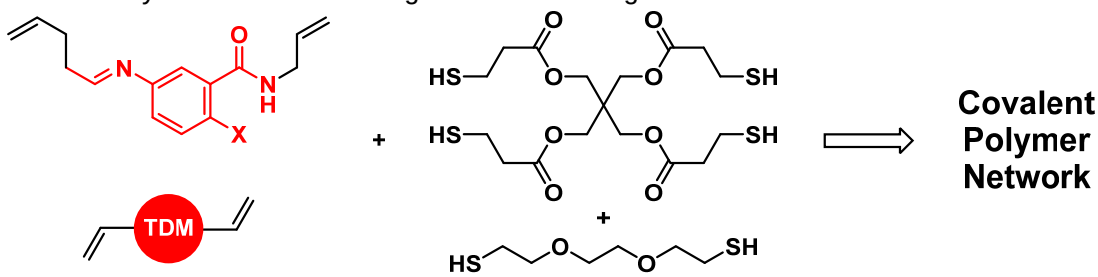

Figure 2. *Overview of the network forming reactions (photoinitiator and UV illumination are not shown). Small modification in the structure of building blocks other than the TDM building block is possible.*

Techniques to be used

Synthetic techniques, various chromatographic separation and isolation techniques, NMR, Mass spectrometry, GPC, UV/vis, DLS, AFM, rheometry and electron microscopy.

For more information

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