# DEVELOPMENT OF OPTIMIZED AUTONOMOUS SELF-HEALING SYSTEMS BASED ON HIGHLY EFFICIENT REACTIONS

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## ABSTRACT

Throughout their lifetime, polymers used in for example common structural materials and coatings are susceptible to mechanical damage such as wear, degradation, and microcracking, all of them reducing the mechanical properties of these materials. To overcome these limitations, a rapidly emerging field of research has resulted in polymeric materials that can repair crack damage in an autonomous fashion, and they are referred to as self-healing materials.

An important strategy is based on the incorporation of microcapsules, which contain the self-healing agents (monomers or network precursors) that can (co)polymerize or cross-link upon rupture of the capsules as a result of mechanical damage.

In this contribution, we have aimed to fundamentally improve the basic concepts of the specific chemistries that are currently applied in the microencapsulation approach for epoxy resins. We have explored various highly efficient chemical reactions as a novel chemical concept for self-healing applications. Reactions were selected that outperform in reaction rate, selectivity, and occur under mild conditions, as we believe they show great potential for self-healing applications.

In particular, we have focused on the maleimide conjugate addition reaction of various thiols and amines with maleimide derivatives. Various model reactions with monofunctional reagents were performed in order to study the reaction kinetics in detail. The system was then extended to multifunctional reagents to induce network formation. Moreover, we have shown that these reactions are catalyzed by tertiary amines, that are present in the epoxy matrix.

The feasibility of the use of these novel healing agents was verified by tapered double cantilever beam (TDCB) tests, whereby the healing agents were manually injected into the crack plane. At the same time, we are working on the microencapsulation of the presented healing agents.