Title

CLICK CHEMISTRY: TOWARDS SELF-HEALING POLYMER COMPOSITE

Abstract text

Structural materials are susceptible to long-time natural or artificial degradation processes, leading to damage in the form of microcracks which is difficult to detect and which can, eventually, cause a failure in service. Smart materials that are able to self-heal by retarding and repairing micro-cracks prior to catastrophic failure are therefore of great interests and have been an active topic of research in the last decade. Numerous methods have been attempted towards this goal, including conventional ones such as thermal welding, resin injection and reinforcing patch. More recent strategies to achieve self-healing include pre-storing healing agents in hollow glass tubes, microcapsules, and microvascular systems.

In this fundamental study, a photo-healable rubber composite based on effective and fast thiol-alkyne click chemistry as self-healing agent prestored in glass capillaries is prepared. The click reaction and its effect on the mechanical properties of the composite is recorded in real time by dynamic mechanical analysis, showing that the successful bleeding of the healing agents to the crack areas and the effective photoinitiated click reaction results in a 30% storage modulus increase after only 5 min of UV light exposure. X-ray tomography confirms capillary-driven bleeding of reactants to the damaged areas. No reactant degradation or premature chemical reaction is observed over time in samples stored in absence of UV radiation; they are able to undergo the self-healing reaction even one month after preparation.

We anticipate that the self-healing approach presented here could be applied to a wide range of polymer composites. As an example of further development, we present preliminary data on the autonomous and repeatable repair of stiffer matrices using a combination of cutting edge polymer chemistry reactions and nanostructured reinforcing carriers containing the healing agents.

Keywords

POLYMER COMPOSITE, SELF-HEALING, CLICK CHEMISTRY, TOMOGRAPHY

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