

REMEMDABLE INTERFACES FOR POLYMER COMPOSITES

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ABSTRACT

Interfacial damage is a major source of failure in fiber-reinforced composites. We have developed a method of healing at the resin-reinforcement interface based on the Diels-Alder reaction of furan and maleimide. The polymer network is a furan-functionalized epoxy-amine thermoset, while the reinforcement material is maleimide-functionalized glass fiber. Compatible functionalization of the polymer matrix and glass fiber results in a thermoreversible and remendable interface. Healing is induced by heating and subsequent cooling, allowing for Diels-Alder bonds to degrade and subsequently reform. Based on this method of determining healing efficiency, the system reported demonstrates 42% healing efficiency with healing possible for up to five cycles.¹

The furan-functionalized network has previously been used in the investigation of bismaleimide solutions as room temperature healing agents.² Glass fibers were maleimide-functionalized through a simple two-step process. Interfacial healing was evaluated with single fiber microdroplet pull-out testing. Equation 1, a new definition of healing efficiency was developed that discounted for frictional and inertial forces. Any positive healing efficiency value is the result of the healing procedure.

$$\eta = \frac{(F_{healed,max} - F_{healed,friction}) - (F_{noheal,max} - F_{noheal,friction})}{(F_{initial,max} - F_{initial,friction}) - (F_{noheal,max} - F_{noheal,friction})} \quad (1)$$

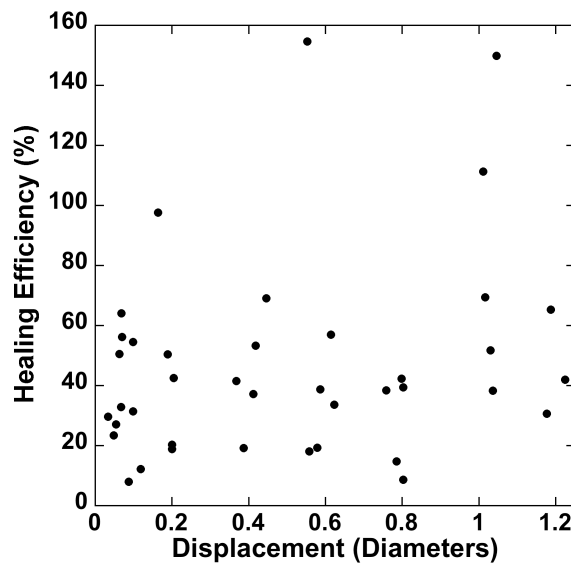


Figure 1: Healing as a function of displacement normalized by droplet diameter.

Healing efficiency as a function of diameters displaced prior to healing are given in Figure 1. No relationship exists between healing efficiency and displacement. Healing was also shown to be independent of network furan content, as long as the network contained furan. However, ongoing work suggests that furan content plays a more important role in dictating healing efficiency at higher T_g s, presumably because of mobility limitations.

Compatible functionalization of polymer and reinforcement represents an effective method of healing interfacial damage. Functionalization is simple and can be applied to many systems. Ongoing work includes understanding the parameters significant for healing and investigating the ability to heal damage on a larger scale.

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