CURE DEVELOPMENT AND ADHESIVE FRACTURE TOUGHNESS OF ROMP HEALING AGENTS

Michael R. Kessler[*], Jong Keun Lee[*‡], Xing Liu[*‡], Louis H. Charles[*], Xia Sheng[*]

[*] Materials Science and Engineering
Iowa State University
Ames, IA 50011, USA
mkessler@iastate.edu

[‡] Polymer Science and Engineering
Kumoh National Institute of Technology
Gyungbuk 730-701, Korea

Self-healing polymers and composites offer promise in significantly extending the life of structural components by autonomically healing microcracks whenever and wherever they develop [1,2]. In these systems, healing is accomplished by incorporating an embedded healing agent (in microcapsules or hollow fibers) and a chemical trigger within a thermosetting matrix. Upon damage, internal cracks rupture the embedded microcapsules or fibers, releasing the healing agent into the crack plane where subsequent polymerization bonds the crack faces—effectively healing the material. Requirements for successful healing agent systems are severe and include long shelf life, excellent adhesive strength with the polymer matrix and reinforcement phases, rapid polymerization at room temperature, and insensitivities to non-ideal mixing with the initiator.

In this paper we evaluate the polymerization and adhesive fracture toughness of several norbornene-based monomer systems as candidate healing agents in self-healing composites: *endo*-dicyclopentadiene (*endo*-DCPD), *exo*-DCPD, 5-ethylidene-2-norbornene (ENB), and various mixtures with custom crosslinking agents. The ruthenium catalyst induced ring-opening metathesis polymerization (ROMP) of the healing agent candidates are evaluated using parallel plate dynamic mechanical analysis and differential scanning calorimetry. A width-tapered double cantilever beam fracture specimen is used to evaluate the adhesive fracture toughness between the polymerized healing agent candidates and an epoxy matrix. Two different triggering mechanisms are used in both the rheometry experiments and the fracture experiments. In the first case, the healing agent is first homogenously mixed with the healing agent before polymerization; in the second case, the catalyst is mixed with an epoxy resin and cured into a composite, which is then polished to expose to the catalyst to the healing agent during the experiments (simulating the self-healing process). The consequences of the polymerization kinetics (including the mechanical property development with cure) and the adhesive fracture toughness measurements for different healing agent candidates to *in-situ* self-healing applications are discussed.

References

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