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Preparation and Properties of Self-Healing Polyurethanes Utilizing the Host-Guest Interaction between Cyclodextrin and Adamantane Moieties

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Abstract : Self-healing polymers have attracted attention because their physical damage and cracks can be effectively repaired, thereby extending the lifetime of the materials. Self-healing polymers using host-guest interaction have the advantage that they are quickly repaired under mild temperature conditions when compared with self-healing polymer using dynamic covalent bonds such as Diels-Alder (DA)/retro-DA and disulfide metathesis reactions. Especially, it is known that hydrogels utilizing the host-guest interaction between cyclodextrin and various guest molecules are repeatedly self-repaired at room temperature. However, most of the works deal with hydrogels, and little attention has been paid for thermosetting resins as polyurethane, epoxy and unsaturated polyester resins. In this study, polyetherurethane networks (PUN-CD-Ads) incorporating cyclodextrin and adamantane moieties were prepared by the crosslinking reactions of β-cyclodextrin (CD), 1-adamantanol (AdOH), glycerol ethoxylate (GCE) and hexamethylene diisocyanate (HDI), and thermal, mechanical and self-healing properties of the polymer network films were investigated. Our attention was focused on the influences of molar ratio of CD/AdOH, GCE/CD and OH/NCO on the properties. The FT-IR, and gel fraction analysis revealed that the urethanization reaction smoothly progress to form polyurethane networks. When two cut pieces of the films were contacted at the cross-section at room temperature for 30 seconds, the two pieces adhered to produce a self-healed film. Especially, the PUN-CD-Ad prepared at GCE/CD = 5/1, CD/AdOH = 1/1, and OH/NCO = 1/1 film exhibited the highest healing efficiency for tensile strength. Most of the PUN-CD-Ads were successfully self-healed at room temperature.

Keywords : host-guest interaction, network polymer, polyurethane, self-healing
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