

ABSTRACT

In today's society the widespread application of polyurethanes (PUs) motivates to design PU based materials with improved properties. This study reports the preparation of new classes of functional PUs with ionic/furan/disulfide moieties which show interesting self-healing and shape-memory properties. The functional PUs were characterized using FT-IR, ¹H-NMR, GPC, TGA, DSC, SAXS, WAXS, AFM and FESEM analyses. Self-healing property of functional PUs were evaluated by tensile test, as well as by monitoring the disappearance of the crack using optical microscopy. Shape-memory property was evaluated using cyclic tensile test. The incorporation of ionic liquid crosslinker into the hard segment of PUs improved the phase separation and reduced the T_g, whereas the non-ionic crosslinker resulted in mixed phase morphology and increased T_g. PUs with ionic liquid crosslinker exhibited superior shape-memory property than the conventional non-ionic crosslinked PU or linear PU. The ionic liquid moiety was also incorporated into the soft segment (polycaprolactone, PCL) and subsequently used in the preparation of PUs. Incorporation of ionic liquid moiety into the soft segment of PUs resulted in interesting self-healing property which can improve the application life of the material. PU functionalized with pendant furan moiety (FPU) was prepared using a novel chain extender and was grafted with maleimide functionalized polyhedral oligomeric silsesquioxanes (POSS maleimide isobutyl, POSS-M) via Diels-Alder (DA) "click" reaction. Grafting of POSS-maleimide molecules on to the furan containing PU via DA reaction improved the surface hardness, hydrophobicity and self-healing properties which are important in coating application. Functional PU having disulfide and furfuryl moiety (DSF-PU) was prepared using a novel chain extender having a disulfide as well as furfuryl functionality. This resultant PU (DSF-PU) on crosslinked with bismaleimide (BM) via Diels-Alder (DA) 'click' reaction showed remarkably high tensile strength (~40 MPa) as well as self-healing efficiency (~97%).

Keywords: polyurethane, functional polyurethane, shape-memory, self-healing, ionic liquid, Diels-Alder reaction, disulfide metathesis reaction.