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High clarity poly(caprolactone diol)-based polyurethane adhesives for polycarbonate lamination: effect of isocyanate and chain-extender

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Abstract

The development of a high clarity polyurethane adhesive from a crystalline soft-phase capable of bonding untreated and ethanolamine surfaced-treated polycarbonate is described. A series of polyurethanes were prepared, based on poly(caprolactone diol), selected as the soft-phase as its ester-functionalised backbone structure will assist the adhesive performance. A high crystallinity soft-phase, however, will have an adverse effect on the adhesive's clarity. However, through careful design of the hard-phase architecture, it is possible to address this issue. Eight formulations were synthesised each with a subtly different hard-phase architecture, created using a combination of methylene diphenyl diisocyanate or isophorone diisocyanate with trimethylol propane only or by including the chain-extenders 2,2-diethyl-1,3-propane diol, 1,3-butane diol and 1,2-propane diol. DSC and FTIR data show that having trimethylol propane alone is not sufficient in disrupting soft-phase crystallisation in the methylene diphenyl diisocyanate formulations, and that for total removal of soft-phase crystallisation a diol chain-extender is required to promote phase mixing within the microphase structure. This reduces peel strengths but values remain above 3 N mm^{-1} on both untreated and ethanolamine treated polycarbonate after 18 months. More importantly, the change to the morphology markedly improves clarity. In contrast, isophorone diisocyanate systems show poor phase mixing even in the presence of the chain-extenders and, although offering good peel strengths, have low clarity.

KEYWORDS

Polyurethane; adhesive; morphology; lamination; clarity

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