

ORTHOGONAL REACTION KINETIC EFFECTS ON NETWORK MORPHOLOGY IN HYBRID PHOTOPOLYMERIZED SYSTEMS

Tanner Grover and C. Allan Guymon

Department of Chemical and Biochemical Engineering, University of Iowa,
4133 Seamans Center, Iowa City, IA 52242, USA

Stereolithography has been investigated as a manufacturing process for producing functional parts with complex geometry. Acrylic resins are commonly used because of their fast reaction kinetics enabling rapid print speeds but often produce brittle and weak materials due to chemical composition and polymerization mechanism. Conversely, cationic polymerization of cyclic ethers (e.g., oxiranes and oxetanes) follows a different mechanism that can produce tougher materials but suffers from slow kinetics. In this work, we combined orthogonal radical and cationic polymerizations into a hybrid printing resin that can maintain fast build speeds and provide improved properties. Small modifications to cationic comonomer ratios enabled significant control over polymer structure and had profound impacts on mechanical performance. The material morphology ranged from highly phase separated, where distinct areas of individual networks are present to highly interpenetrated where the two networks are interlocked and separate phases are almost indistinguishable. The degree of interpenetration/phase separation was found to be dependent on reaction rate between the two polymerizations. Greater network interpenetration led to stiffer materials with high ultimate strength while more phase separated materials exhibited a more flexible tensile behavior and maintains a similar toughness (Fig. 1). These characteristics were provided by the respective domain attributes which differed considerably in chemical composition and crosslink density.

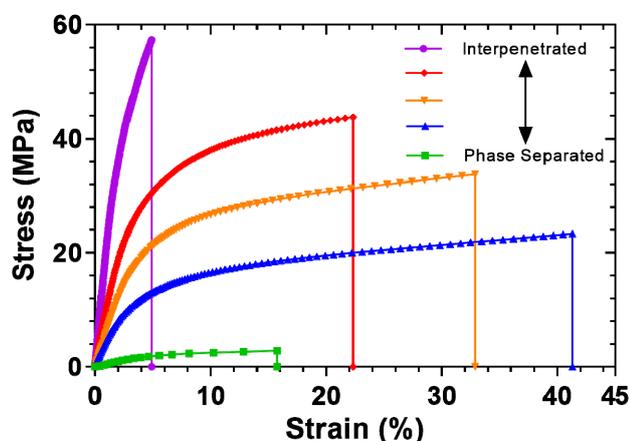


Figure 1. Tensile testing of the studied hybrid photopolymerizable system. Material morphology ranged from full interpenetration to highly phase separated and could be controlled to slight modifications of cationic monomer ratios.