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From Homogeneous to Phase Separated UV-Cured Interpenetrating Polymer Networks: Influence of the System Composition on Properties and Microstructure

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Abstract : Acrylates are widely used in UV-curing technology. Their high reactivity can, however, limit their conversion due to early vitrification. In addition, the free radical photopolymerization is known to be sensitive to oxygen inhibition leading to tacky surfaces. Although epoxides can lead to full polymerization, they are sensitive to humidity and exhibit low polymerization rate. To overcome the intrinsic limitations of both classes of monomers, Interpenetrating Polymer Networks (IPNs) can be synthesized. They consist of at least two cross linked polymers which are permanently entangled. They can be achieved under thermal and/or light induced polymerization in one or two steps approach. IPNs can display homogeneous to heterogeneous morphologies with various degrees of phase separation strongly linked to the monomer miscibility and also synthesis parameters. In this presentation, we synthesize UV-cured methacrylate - epoxide based IPNs with different chemical compositions in order to get a better understanding of their formation and phase separation. Miscibility before and during the photopolymerization, reaction kinetics, as well as mechanical properties and morphology have been investigated. The key parameters controlling the morphology and the phase separation, namely monomer miscibility and synthesis parameters have been identified. By monitoring the stiffness changes on the film surface, atomic force acoustic microscopy (AFAM) gave, in conjunction with polymerization kinetic profiles and thermomechanical properties, explanations and corroborated the miscibility predictions. When varying the methacrylate / epoxide ratio, it was possible to move from a miscible and highly-interpenetrated IPN to a totally immiscible and phase-separated one.

Keywords : investigation of properties and morphology, kinetics, phase separation, UV-cured IPNs
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