Project title: Photopolymerization Analysis of Hydrogels

Project description:

Photopolymerization is a widely used technique to synthesize polymers and hydrogels. The commonly used ultra-violet (UV)-curable mono-, di- or multifunctional vinylated monomers or macromonomers are often volatile, causing difficulty in the accurate measurement of reaction kinetics using Photo Differential Scanning Calorimetry (PhotoDSC). In this work, the PhotoDSC pan was treated with a PDMS solution to provide consistent sample loading and uniform sample exposure to UV light. Physical treatment on the PhotoDSC pan made it possible to seal the sample pan, thus a minimum sample weight loss was achieved during measurement. Such treatment substantially improved experimental accuracy for volatile materials (Figure 1), which in turn provides a better understanding of the reaction kinetics of UV-curable polymers.

The copolymerization of HEMA/DEGDMA and MAA/TEGDMA were studied by PhotoDSC using the modified sample pans. The reaction rate was enhanced as the light intensity increased, especially at a low light intensity range and low conversion. At a high light intensity, an adverse effect was observed. The optimal light intensity for poly(HEMA) hydrogels was about 5 mw/cm^2, while 2.5 mw/cm^2 for poly(MAA-g-EG) hydrogels (Figure 2).

The solvent added to the hydrogels has a great influence on the reaction kinetics of photocurable materials. With the solvent, the photopolymerization rate decreased and multiple exothermic peaks was observed on the reaction rate profiles. Without the solvent, the tail at the later stage of polymerization was not observed. The propagation and termination rate constants k_p and k_t were determined through the steady and unsteady photopolymerization. The dependence of these kinetic constant as a function of conversion explained the conversion profiles and the occurrence of multiple exothermic peaks observed during the photopolymerization.

Figures:

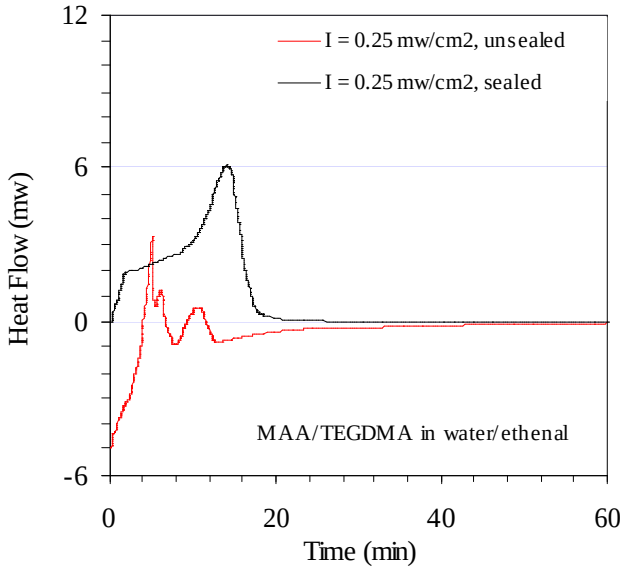

Fig. 1. Comparison of PhotoDSC measurement in a sealed and unsealed pan

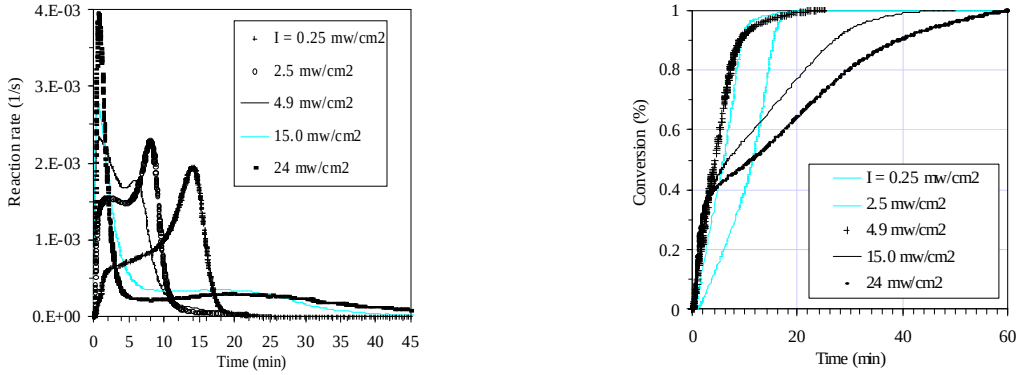

Fig. 2. Effect of light intensity on the polymerization of MAA/TEGDMA (in water/ethanol) in the presence of 1% Irgacure 651 (a) reaction rate, (b) conversion.