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Simulation and experimental analysis of photopolymer media in holographic memory

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Abstract

Photopolymers are suitable for a medium of holographic data storage and stable media with high diffraction efficiency. The reaction process of such photopolymers proceeds based on elementary reactions and it is highly complicated. In present work, we have simulated formation of diffraction gratings in photopolymers, and analyzed their diffraction characteristics according to the beam propagation method. In addition, we also performed experiment for evaluation of recording characteristics of photopolymers by interference fringe recording. For extracting the rate constants of propagation and termination, data fitting was performed in the initial rise portion of the diffraction efficiency by using newly developed simulator. It was confirmed that the simulation of multiplexed recording using the extracted parameters agreed fairly well with the experiment. Thus, the developed recording-reproducing process simulator will be useful for evaluating holographic recording media.

Key words: *Optical properties/techniques, Analytical modeling, Numerical analysis, Polymer-matrix composites*

1. Introduction

Photopolymers, the most widely studied holographic recording media (Hans *et al*., 2000; Dhar, 2004), undergo a complex reaction-diffusion process for recording. Photopolymers are characterized by high sensitivity, high dynamic range, low scattering noise, and long archival life and so are widely used as holographic recording media. However, the monomer diffusion and reaction process is highly complex. The main problems for holographic data storage are dark reaction, media shrinkage, and sensitivity to temperature changes. Some researchers have proposed reaction models based on diffusion (Zhao and Mouroulis, 1994; Sutherland *et al*., 2004; Kelly *et al*., 2005; Sheridan and Lawrence, 2000; Aubrecht *et al*., 1998; Kelly *et al*., 2005; Gleeson *et al*., 2006). In these studies, the formation of holographic gratings was analyzed. In general, to analyze diffraction characteristics of optical elements, coupled-wave analysis (Kogelnik, 1969) is widely used. However, these methods are unsuitable for the analysis of complex interference gratings such as multiplexed holographic gratings. Toishi *et al*., simulated the polymerization process based on their own diffusion

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