

Highly sensitive formation of stable surface relief structures in multi-anthracene films

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Research on photofunctional soft organic materials is an increasingly important area in photonic device systems because of their processability and flexibility. Since the pioneering two reports on photoformation of surface relief gratings (SRGs) in azobenzene-functionalized polymer films, azobenzene-containing materials have received much attention because of their basic phenomenological interest and their potential technological applications. However, azobenzene-containing materials absorb visible light, which limits their potential for optical applications. In order to broaden the application field of SRGs, our researches focus on SRG forming materials that do not have visible absorption band.^[1] Recently, we have succeeded in photoformation of SRGs using amorphous films of low-molecular-weight photochromic spirooxazine^[2] as well as polystyrene^[3] films containing no photochromic agent. In this research, we designed photopolymerizable compounds having multi-anthracene units, expecting both the highly photosensitive SRG formation and the high stability of the resultant SRG (Fig. 1).

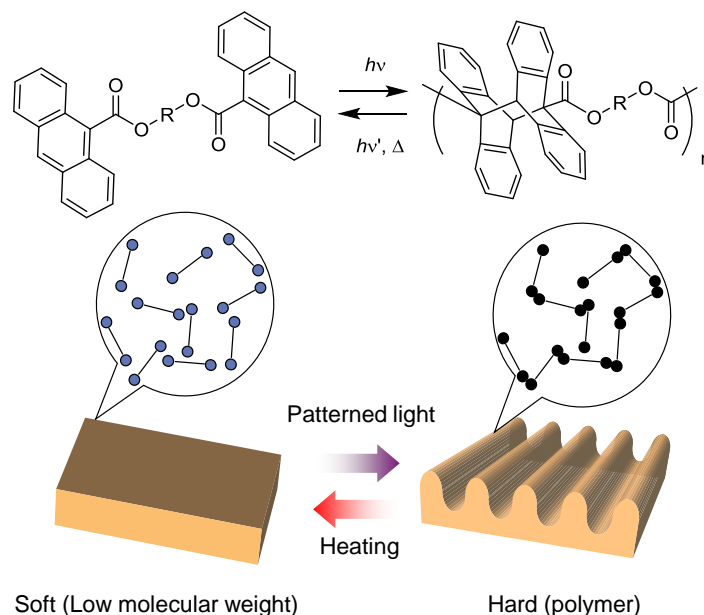


Figure 1 Schematic illustration surface relief grating using photopolymerizable compounds.

UV-visible absorption spectroscopy and gel permeation chromatography confirmed that irradiation of UV (365 nm) light induced polymerization of bisanthracenes in amorphous films. When the amorphous films of bisanthracenes were irradiated with spatially patterned UV light while heating above their glass transition temperatures, regular sinusoidal surface modulations were produced (Fig. 2). The convex surface relief structures produced by slit light clearly revealed that the lateral mass transfer occurred from the shaded areas to the irradiated areas. It is noteworthy that such surface reliefs were produced by extremely low exposure energy (0.1 mW cm^{-2} , 10 min). Thus, the efficiency of SRG formation for the bisanthracenes was approximately two orders of magnitude higher than that for the photochromic spirooxazine and the polystyrene. Moreover, the stability of the resultant SRG was improved by the polymerization of the bisanthracenes in the process of SRG formation.^[4]

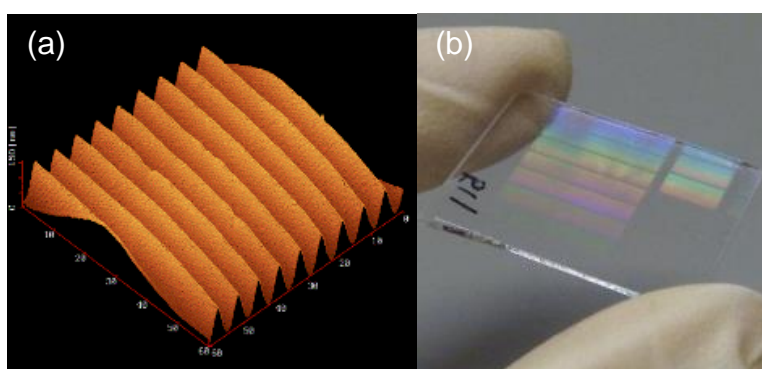


Figure 2 Atomic force microscopic image (a) and photograph (b) of SRG formed on bisanthracene film

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Reference:

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