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Holographic grating formation in poly(methacrylate) containing pendant xanthene dyes

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Poly[3′-(m-methacryloyloxyalkyloxy)-2′,4′,5′,7′-tetrabromofluorescein] and poly[3′-(m-metha cryloyloxyalkyloxy)-2′,4′,5′,7′-tetraiodofluorescein] were synthesized by free radical addition polymerization method. Thermal properties of the polymers such as T_g and thermal stability of the polymers were studied by DSC and TGA. Holographic grating formation was formed on the polymeric film using Ar^+ ion laser. Substituent effect on diffraction efficiency of the polymers was investigated. The diffraction efficiency of the polymers was studied with varying concentration of the film and writing beam intensities.

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1. Introduction

Photopolymers have been of attraction over the past two decades because of their photonic applications such as holographic data storage, optical information processing and communication technology, etc [1-3]. The potential application of photopolymers for optical data storage was first demonstrated by Todorov et al [4]. Many reports were discussed for optical data storage on the polymer films using Ar^+ ion laser [5-7]. Several methods of film formation have also been investigated such as spin coating [8], Langmuir-Blodgett deposition [9] and sol-gel [10] thin film process to control the thickness and composition of the films to achieve optical quality film for holographic grating formation. Natansohn et al discussed that liquid crystallinity is not an essential criteria for reversible data storage but amorphous polymers are also good candidate for data storage [11]. Ramanujan et al reported that high diffraction efficiency achieved in side chain polymer films by means of biphotonic processes [12]. Min Gu et al reported that two photon excitation of PMMA based photorefractive polymers provides a rewritable 3D bit optical data storage [13]. In general, the xanthenes possess intense and narrow absorption band [14]. Manivannan et al reported that xanthene dyes having holographic data storage property in which electron transfer mechanism involved [15]. The gratings are produced with an interference pattern created from coherent laser light at a wavelength absorbed by the material.

The present work describes hitherto unreported covalently linked eosin yellow and erythrosin-B containing polymethacrylates. They were synthesized and characterized; further their thermal, holographic grating formation and diffraction efficiency have been investigated.

2. Experimental

2.1 Materials and method

2′,4′,5′,7′-tetrabromofluorescein (Eosin yellow acid), 2′,4′,5′,7′-tetraiodofluorescein (Erythrosin-B acid), potassium carbonate, potassium iodide (KI), tetrabutylammonium bromide (TBAB) (s.d.fine, India), methacrylic acid, benzoyl chloride, 1,6-hexanediol, 1,8-octanediol and 1,10-decanediol (E-Merck, Germany), hydrobromic acid (40%) (Spectrochem, India) were used as received. Dimethyl formamide (DMF), methanol, acetone and tetrahydrofuran (THF), triethylamine (TEA) (SRL, India) were purified by the usual procedure [16] and dried before use. Three m-bromoalkanols (m = 6, 8, 10) were prepared by using reported procedure [17]. Methacryloyl chloride was prepared by the procedure reported elsewhere [18]. 2, 2′-Azobisisobutyronitrile (AIBN) was recrystallized in chloroform-methanol (1:1).

2.2 Synthesis of polymer

2′,4′,5′,7′-tetrabromofluorescein (0.09 mol) was dissolved in dry DMF(20 mL). Anhydrous potassium carbonate (6 mol), catalytic amount of KI and TBAB were added to it. The reaction mixture was heated to 90ºC with stirring; 6-bromo-1-hexanol (0.1mol) was added drop wise to the reaction mixture and heating continued at that temperature for 3 days. The reaction mixture was cooled to room temperature and poured into ice-cold dilute hydrochloric acid solution. The precipitated 3′-(6-hydroxyhexyloxy)-2′,4′,5′,7′-tetrabromofluorescein was filtered, washed with water until neutral and then dried. 3′-(6-hydroxyhexyloxy)-2′,4′,5′,7′-tetrabromofluorescein (0.01 mole) was dissolved in dry THF (20 ml) and dry