The effects of organic additives on photochromism. Part I: the photochromic performance of (E)-dicyclopropylmethylene-(2,5-dimethyl-3-furylethylidene)-succinic anhydride and ferrocene containing dye doped in PMMA polymer film

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Abstract
Purpose – To evaluate the photochromic performance of fulgide **1-E** with ferrocene in polymer matrices.
Design/methodology/approach – The fulgide **1-E** with ferrocene dye **2** doped in polymethylmethacrylate was prepared and the effects of UV irradiation were studied using spectrophotometer. The reversible reaction was effected using white light. The effect of heat was also determined.
Findings – A film of the brown coloured fulgide **1-E** with ferrocene doped in PMMA polymer was irradiated with ultraviolet light (365 nm), the film turned red. The later colour was partially switched back to the original brown colour when the film was irradiated with a white light. It was found that the rate constants of photocoloration reaction at initial stages are faster than those at late stages. Similarly, the photocoloration reaction was slower than the photobleaching reaction. Photocoloration reaction decreased with the increase of the annealing temperatures, but for photobleaching reaction, the rates were almost similar (at 46 and 82°C). The fatigue resistance of the film was greatly improved when the annealing temperature increased to 82°C.
Research limitations/implications – The polymethylmethacrylate polymer doped photochromic fulgide **1-E** and ferrocene **2** described in the present paper was prepared and studied. The principle of study established can be applied to any type of polymer or to any type of photochromic compounds.
Practical implications – The photochromic materials developed can be used for different applications, such as coatings and holography.
Originality/value – The method developed may be used to enhance the performance of photochromic materials.

Keywords Chemical analysis and testing, Polymers, Fatigue, Photochemistry

Paper type Research paper

Introduction

Fulgides were shown to have good thermal irreversible photochromic properties (Yokoyama, 2000). Heller and Langan (1981) had shown that fulgides containing heterocyclic structure such as furyl, thienyl and pyrrolyl were excellent candidates for data storage media because of their efficient thermal stability. Other heterocyclic structures were also studied (Wolak *et al.*, 2001). Indolylfulgides, mainly studied by Yakoyama and co-workers were found to have interesting photochromic properties (Yokoyama and Takahashi, 1996; Wolak *et al.*, 2002). Organic photochromes such as fulgides have found potential applications in fields of optical storage memories (Chen *et al.*, 2005a, b), holographic recording (Chen *et al.*, 2004), and multi-level recording (Chen *et al.*, 2005a, b). The application of photochromic compounds in optical data storage or any other application must certainly be provided as films. This necessitates studying the photochromic performance of fulgides doped in or bounded to polymer matrices. In previous series of papers, the photochromic properties of PMMA polymer films of **1-E** fulgide were reported (Bahajaj and Asiri, 2006). Now we report the photochromic properties of the same fulgide doped in PMMA film with ferrocene **2** at various annealing temperatures (Figure 1).

Experimental

Fulgide **1-E** was prepared according to general procedure previously reported (Asiri, 1997). Ferrocene dye **2** was previously prepared and reported by the author (Asiri, 2001). The films were prepared as follows: about 0.5 g of PMMA (Aldrich product) was dissolved in about 0.2 ml of toluene.

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