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The Radiation-Induced Coloration of Dithienylethene Amorphous Films

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The Radiation-Induced Coloration of Dithienylethene Amorphous Films

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*The radiation-induced coloration of bulk amorphous films of five photochromic diarylethenes was studied with the aim of developing reusable, sensitive color dosimeters. Although amorphous films of bisbenzothienylentene derivatives **3**, **4** and **5** exhibited only weak coloration upon γ-irradiation, intense coloration was observed for the film containing 1,2-bis(2,4-dimethyl-3-thienyl)perfluorocyclopentene **1** having diphenylphenyl substituents. The color was stable in the dark, but disappeared upon irradiation with visible light. The sensitivity remained at 80% of the initial value even after 10 cycles.*

Keywords: amorphous; color dosimeter; diarlylethene; films

INTRODUCTION

Dosimeters based on radiation-induced coloration are widely used in radiation processing, such as radiation curing and radiation sterilization of medical products. These color dosimeters suffer from low sensitivity and storage instability. Recently we have developed a new type of color dosimeter based on radiation-induced coloration of photochromic diarylethenes [1–4]. Thermally reversible photochromic compounds, such as spirobenzopyran or azobenzene derivatives, can not be used for the dosimeters because the color generated by radiation

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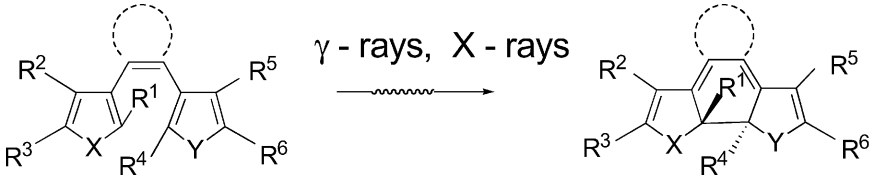
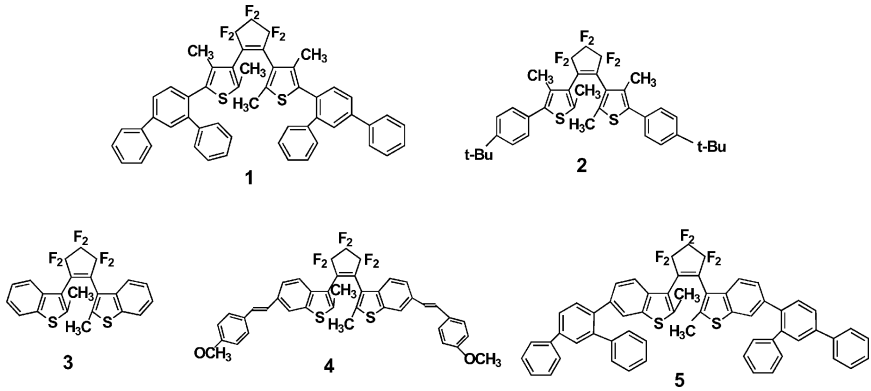
disappears in the dark. Thermally irreversible photochromic performance is a necessary condition for the color dosimeters. Diarylethenes with heterocyclic aryl groups can be used for the dosimeters because the colored state remains stable after irradiation and never returns to the colorless state in the dark.



Although so far polymer matrices were used to prepare films containing photochromic dyes, the polymer systems have drawbacks, such as limited content of the dyes. Bulk amorphous films of diarylethenes are ideal, because in the bulk films high energy radiation is effectively used for the coloration without loss of energy during energy migration or transfer.

RESULTS AND DISCUSSION

In this study, we studied the radiation-induced coloration of five amorphous diarylethene films, as shown below.



The diarylethene amorphous films were prepared by spin coating of the toluene solutions containing these compounds or heating the compounds using a hot stage (Mettler FP 80 type). The films were irradiated with Co-60 γ-rays at room temperature.

The radiation sensitivity was not high when the amorphous diarylethenes have benzothiophene aryl groups (compound **3**, **4** and **5**). An amorphous film of bisbenzothienylperfluorocyclopentene

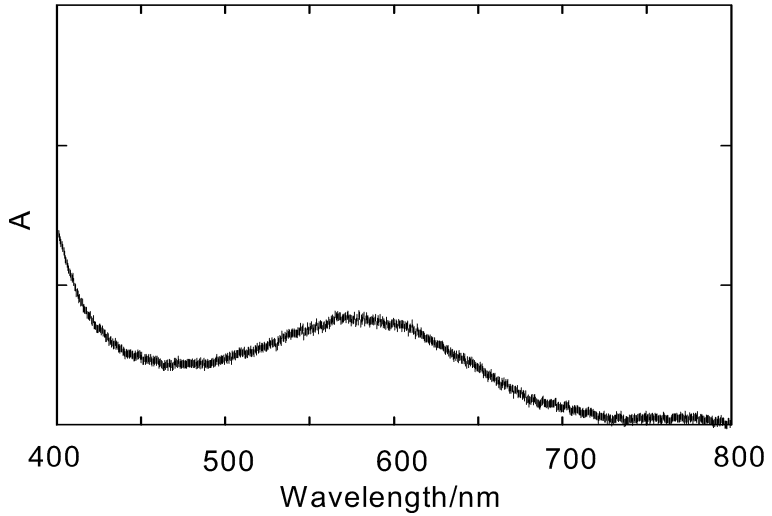


FIGURE 1 Absorption spectrum of the amorphous film of diarylethene **1** upon irradiation with 500 Gy.

5 having diphenylphenyl substituents scarcely exhibit coloration upon γ-irradiation. On the other hand, intense coloration was observed for the film containing 1,2-bis(2,4-dimethyl-3-thienyl)perfluorocyclopentene **1** having diphenylphenyl substituents. Before irradiation the amorphous film was colorless. Upon γ-irradiation of 500 Gy, the film turned blue and the absorption maximum was observed at 570 nm, which is the same as that of the closed-ring form produced by ultraviolet

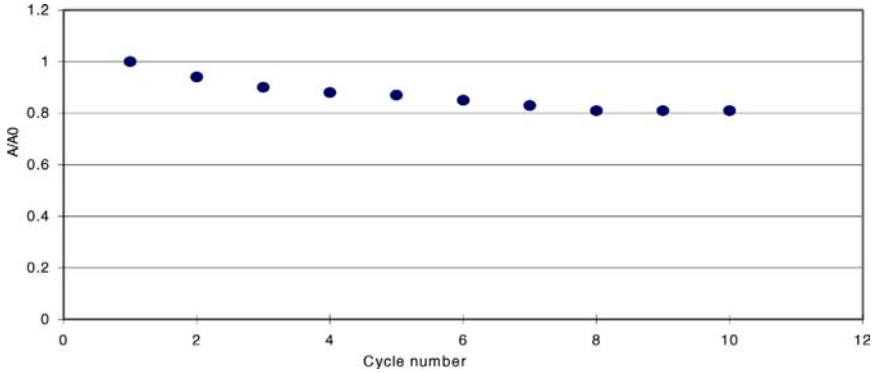


FIGURE 2 Repeated coloration by γ-irradiation and bleaching by visible light.

irradiation [5], as shown in Figure 1. The film thickness was 130 μm. The coloration increased linearly with an increase in the absorbed dose up to 3000 Gy.

Photochromic color dosimeters can be reused, because the radiation-induced color can be erased by visible light irradiation. For the practical application it is necessary to know how many times the film can be reused. Figure 2 shows the reuse ability. The film could be reused after bleaching the color with visible light ($\lambda > 450$ nm). This result indicates that the sensitivity remains at 80% of the initial value even after 10 cycles.

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