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Potential Fire Hazard and Photochemical Tests of Azobenzene of Several Lightning Sources

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Abstract

With the progress of lighting equipment (home appliances such as incandescent light bulbs, fluorescent lamps, LEDs), the reasons for fire accidents caused has changed. These are all light sources used in daily life, but are there any significant differences in terms of light characteristics? As a model system, photochemical experiments of dyes were compared with an experimental light source, sunlight, and a fluorescent lamp. Azobenzene was investigated by using polarized electronic spectra as PMMA films. Besides conventional cis-trans photoisomerization, the optical anisotropy of azobenzene increased by linear polarized UV light due to the Weigert effect. Three types of visible light (Xe lamp, sunlight, and fluorescent lamp) were irradiated to observe the change in decreasing the optical anisotropy.

Keywords: Azobenzene, Fluorescent lamp, Sunlight, Lighting source, Fire.

Introduction

Energy conversion from electricity to light is indispensable to our lives because we cannot live by sunshine alone. There have been many reports of fires causing lighting appliances. Overheating of incandescent light bulbs causes flammable materials to ignite [1,2], fluorescent lamp (having mercury issue [3]) fixtures have deteriorated in their sockets, electrical stabilizers have ignited electricity, and conventional fluorescent light fixtures have LED bulbs attached to them [4]. Of course, the new method has advantages such as energy saving and environmental aspects. On the other hand, for the conversion of energy from light to electricity, practical use and research and development of solar cells are progressing. However, there is a problem that the new artificial light source does not work, and it may not be possible to use it in a scene where sunlight cannot be obtained (for example, a calculator under a fluorescent lamp). Therefore, as an example of testing the possibility of replacing the light source, a model experiment was performed using azobenzene (**AZ**), which is a typical photochromic dye [5].

Discussion

Test samples was prepared by mixing of 1 mL of **AZ** (0.05 mM) and PMMA (10% w/w) DMF solutions (0.05 mM) and casting on glass slides at 50°C to form sample films ((**1a-1c**) *trans*-**AZ** with random orientation). Linearly polarized UV light (generated by Xe lamp and filtered only for < 450 nm) was irradiated to them for 20 min ((**2a-2c**) *cis*-**AZ** aligned in anisotropic orientation). Polarized electronic spectra were measured before (**2a-2c**) and after visible light ((**3a**) fluorescent lamp **(Figure 1)**, (**3b**) solar sunlight, and (**3c**) natural (unpolarized) halogen lamps filtered only for >400 nm) irradiation for 20 min and compared with two parameters, $S = (A_{parrallel} - A_{perpendicular}) / (2A_{perpendicular} + A_{parrallel})$ and $R = A_{perpendicular} / A_{parrallel}$ where $A_{perpendicular}$ and $A_{parrallel}$ are absorbance at polarizer perpendicular to or parallel to the electronic vector of polarized light for irradiation. Ideally isotropic samples exhibit $S = 0$ and $R = 1$ [6].

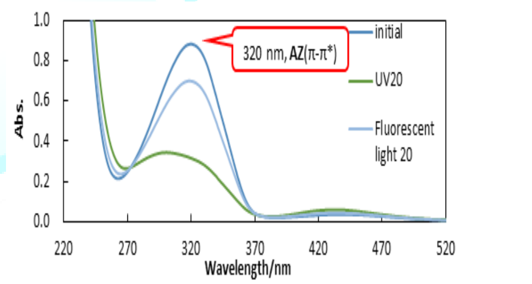

Figure 1: Polarized electronic spectra of initial state (**1a**), after UV light 20 min irradiation (**2a**), and after visible light of fluorescent lamp for 20 min irradiation (**3a**).

As listed in **Table 1**, linearly polarized UV light induced optical anisotropy and each visible light reduced optical anisotropy. At the same time, the absorbance of π-π* bands around 320 nm predominantly decreased by photoisomerization of AZ to the *cis*-form. Each visible light irradiation resulted in photoisomerization to the *trans*-form **(Figure 2)**, in which both fluorescent light and sunlight indicated strong visible light aspect as well as the visible light generated by the Xe lamp regardless of the spectra of light **(Figure 3)**.

Conditions	1		2		3	
	R	*S*	*R*	*S*	*R*	*S*
a	1.0000	0.0000	0.9696	-0.0103	0.9985	-0.0005
b	0.9771	-0.0077	0.9642	-0.0121	0.9905	-0.0032
c	1.0038	0.0013	0.9831	-0.0057	1.0015	0.0005

Table 1: The R and S values measured at 320 nm (π-π* bands).

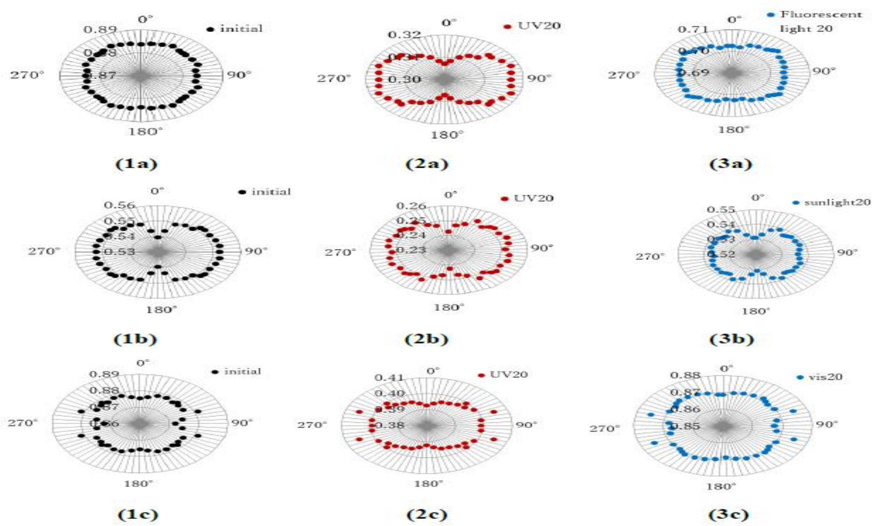

Figure 2: Polarizer's angler dependence of absorbance of polarized electronic spectra.

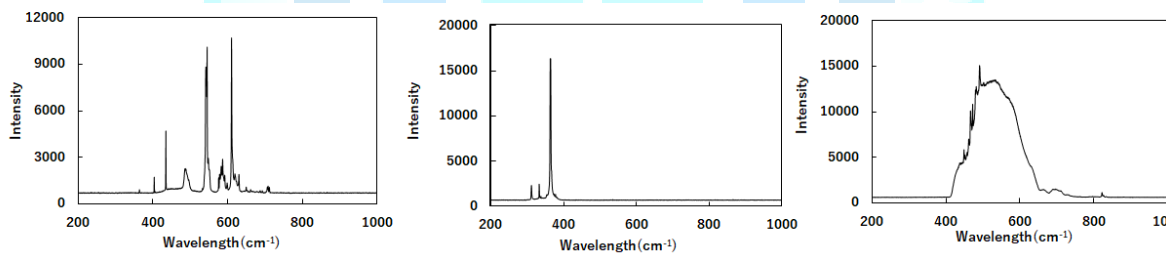

Figure 3: Spectra of light [left] fluorescent lamp for **3a**, [middle] UV light generated by halogen lamp for **2a-2c**, and [right] visible light generated by Xe lamp for **3c**.

Conclusion

In summary, the tested samples were fabricated and irradiated with visible light by fluorescent light, sunlight or Xe lamp, the anisotropy of molecular orientation was reduced due to photoisomerization, and reversibility of absorbance at 320 nm was also confirmed for all cases. Both fluorescent light with some spikes and sunlight of white light have properties as visible light strongly. Except for electric accidents, we hope that the characteristics of energy conversion from electricity to light and heat will be utilized to the lighting to prevent fire at least caused by heat.

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