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Preparation of Polymeric films containing Schiff base as UV-Absorber with Good Resistance against UV-Photoaging

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Abstract: To increase the photostability of polystyrene, a new Schiff base has been added to the polystyrene mixture. The polystyrene films have been exposed to ultraviolet light for 300 hours. Schiff's base has been utilized as a long-term polystyrene optical stabilizer against ultraviolet radiation. Schiff base efficiency is widely recognized for using different techniques, including weight loss determinations, infrared spectroscopy, and electron microscopy (SEM) of PS films after 300 hours of irradiation. Polystyrene/Schiff base blend surface morphology was investigated by SEM technique, and the images demonstrated the formation of terrestrial crack materials due to the presence of photo-stabilizer within the polymer materials. Moreover, the carbonyl group indices were much lower for PS/stabilizer blend than for the blank polymer. The results showed that adding a Schiff base greatly improved the photostability of polystyrene. Furthermore, many unwanted alternations because of the exposure to ultraviolet light were treated by adding the Schiff base compared to the blank polymeric film. The photo-stabilizer absorbs the light and works as a free radical scavenger segment.

Keywords: Schiff base; polystyrene; UV radiation; weight loss; films.

1. Introduction

Due to the increasing global interest in environmental problems reasons via traditional polymeric materials, which are complicated to degrade in the natural environment, biodegradable polymers have attracted attention from industrial and academic areas in past decades [1]. Furthermore, this area was highlighted by researchers because of the wide range of applications for plastic materials in the industry, such as in the organic electronic field to fabricate polymeric light-emitting diode or solar cell [2]. These materials are sometimes used as anti-corrosion substances that cover the metals to stop the corrosion [3-4]. Polymers degrade the original structure via irradiation by bonding, free radical production, permanent bonding cleavages, etc., which break down molecules and form saturated and unsaturated groups [5-6]. These processes present what is called deficiency within materials, which are accountable for

altering the optical, electrical, mechanical, and chemical characteristics of material [7]. In the outdoor environment, the most important severe reason for the degradation is UV radiation, which involves wavelengths that fall, including dissociation energy of the chemical bonds of many of the artificial organic materials utilized in the artwork. Solar radiation and oxygen enhance photosynthetic oxidation reactions on synthetic organic materials. Most of them depend on cleavages of chains and polymers cross-linking reactions utilized as artists' paint materials, like acrylic [8]. Photolysis cause altering in physical and mechanical characteristics of polymers like yellowing, cracking, embrittlement, and hardening of coating films and the changing in the solubility [9-10], and general photolysis processes on polymers begin by absorbing photons from the molecules. The reaction of free radical chains has happened in the propagation stage until new non-radical products are formed by the combinations of radicals in the termination stage. The recombination of macroradicals causes cross-linking within the polymer chains, leading to changing the polymer's physical properties, such as increasing the rigidity and brittleness [11-13]. To inhibit or delay photolysis of the polymer, small molecular photo-stabilizers (such as UV absorbers, scavengers of radical) or inorganic UV screens are added to the polymer matrix during the solubility treatment as the most widely utilized method. Take biodegradable polyesters as an example, UV stabilizers [14-16]. This paper demonstrates the effect of UV irradiation on Schiff base structure doped with polystyrene film by FTIR.

2. Materials and Methods

2.1. Instrumentation.

Fourier spectra for infrared conversion (FTIR) were reported on the Jasco FT / IR-4200 spectroscope (Tokyo, Japan). PS films morphology was examined using a scanning electron microscope (SEM), Inspect S50 (FEI, Czech Republic). For elements abundance, the Bruker XFlash® (Bruker, Tokyo, Japan) was utilized have been utilized.

2.2. Synthesis of Schiff base.

1.90 g, 6.0 mmol of compound 1 was added to 25 mL round bottom flask, and then 0.89 g, 6.0 mmol of 4-(dimethylamino)benzaldehyde was added. After that, ethanol (10 mL) was also added as a solvent. Finally, a few drops of glacial acetic acid was added and left the mixture to stir at reflux for 5 hours. After cooling down the mixture, the crude product was recrystallized from ethanol to produce pure target product compound 2.

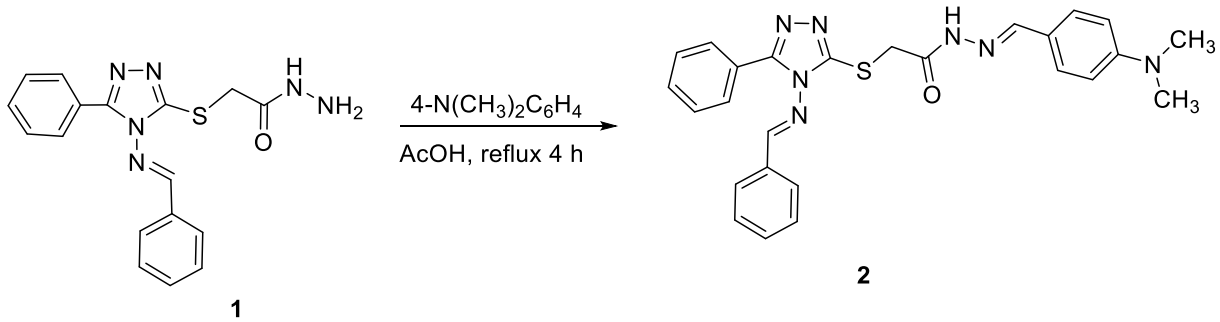

Figure 1. Preparation of Schiff base.

2.3. PS films preparation.

Films with a thickness of (40 µm) of polystyrene (PS), (polystyrene: Schiff base) (99: 1 w/w) were prepared by the technique of pouring the solution using chloroform as a solvent.

The mixture was stirred for 30 minutes, and then the solution was poured on a glass plate [18-21].

2.4. UV light exposure.

The prepared polystyrene films were exposed to ultraviolet light for 300 hours at a maximum wavelength of 313 nm and 6.43 × 10^{-9} ein·dm^{-3}·s^{-1} light intensity. It was used for irradiation of the QUV accelerometer weather-meter (Q -Panel Company, USA).

3. Results and Discussion

Schiff base prepared as presented in Figure 1, where brown precipitation achieved 65% and the melting point range was 110-112 ° C. Schiff base structure has been further confirmed by the FTIR spectrum. The FTIR spectrum indicates strong absorption peaks at 1680, 3057, 2922, 1584, 3500, 739 cm^{-1} assigned to azomethine group (C = N), CH (Ar), CH (Ali), C = C (Ar), NH, and C-S in Schiff base, respectively. Figure 2 shows the observed changes in $I_{C=O}$. These results confirmed the Schiff base's effective use and, in particular, the Schiff base to enhance photo stabilization for PS films [16].

Changing in PS weight after (300 hours) exposure to UV light is shown in Figure 3. It was evident that loss in the polymer weight was bigger for PS (blank) film when compared to PS and Schiff base blend. The PS film containing compound 2 presented less weight loss than PS (blank) [17].

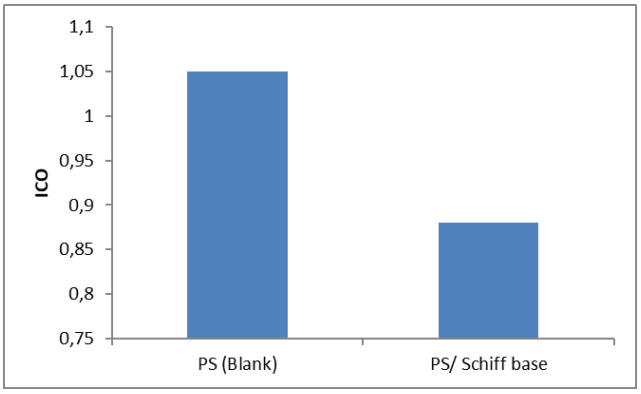

Figure 2. Changing in $I_{C=O}$ of polymeric films.

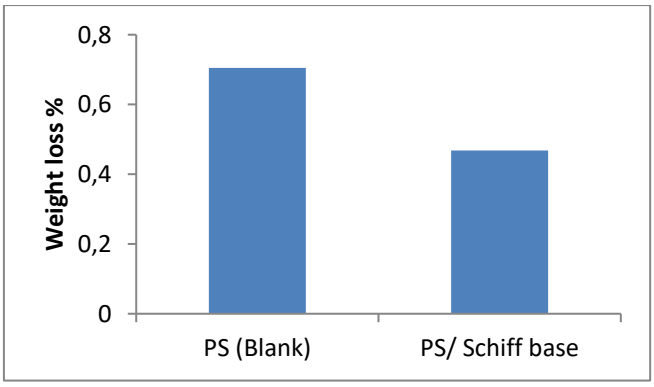

Figure 3. The loss in weight percent changes in the polymeric films.

Use an EDX measurement spot size of 50 nm. The spatial precision of EDX technology is determined by the reaction volume of beam electrons and the sample material and estimated to be approximate. [11]. EDX was used to identify the main elements in polymeric films, in

principle, and to test films' homogeneity [11]. Figure 4 shows that the PS (blank) film shows strong carbon abundance peaks as a major component.

Figure 5 reveals that the emergence of the new bands associated with nitrogen, sulfur, and oxygen from the Schiff base.

SEM images of PS/Schiff base mixture upon irradiation detected that crack-like polymeric material was fabricated (Figure 6). PS-like terrestrial crack materials have significant improvements in light capture power that have resulted in a high degree of optical stability [11]. The formation of terrestrial-like materials can be related to the incorporation of the Schiff base inside PS surface.

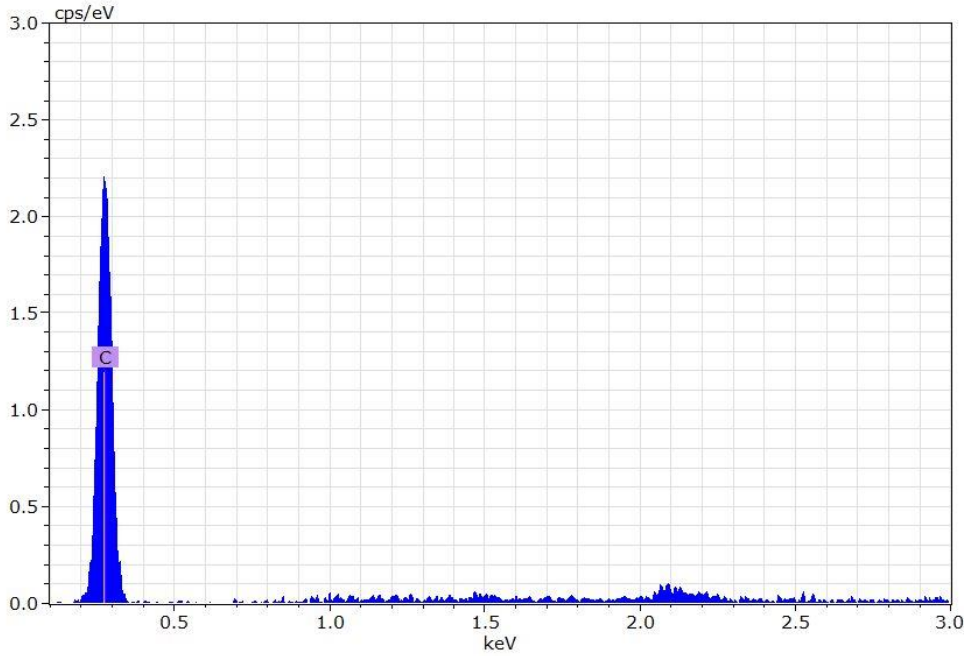

Figure 4. EDX for PS (blank) film.

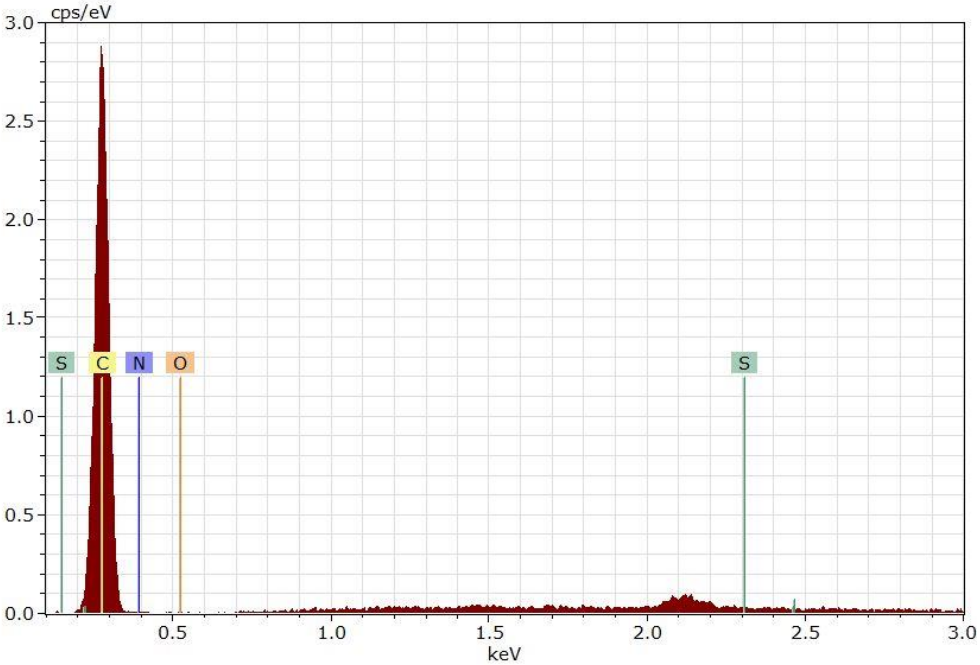

Figure 5. EDX for PS/Schiff base blend.

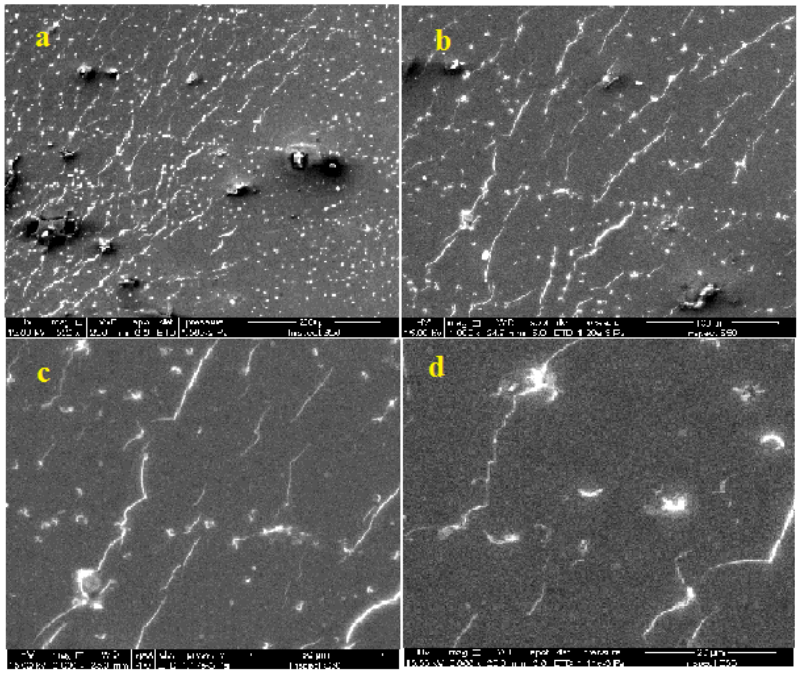

Figure 6. Top view of SEM images of terrestrial cracks-like for PS/Schiff base blend after exposure to UV light (a) 200 µm. (b) 100 µm. (c) 50 µm. (d) 20 µm.

The surface morphology of prepared polymeric films was also studied by utilizing the optical microscopic image technique. This kind of method is applied to exhibit the homogeneity and roughness of the polymer surface and study the alternation that happens on the polymeric film surface before and after exposure to UV light [18]. Figure 7 shows the microscopic images of polystyrene plus compound 2 before and after irradiation. The polymeric surface of PS after irradiation has more cracks, spots, irregularity, and roughness compare to its surface before exposure to UV light. It has also demonstrated that the PS containing photo-stabilizer (compound 2) film surface after irradiation has less damage compare to blank PS. This is in agreement with other studies that compound 2 is worked as an excellent photo-stabilizer.

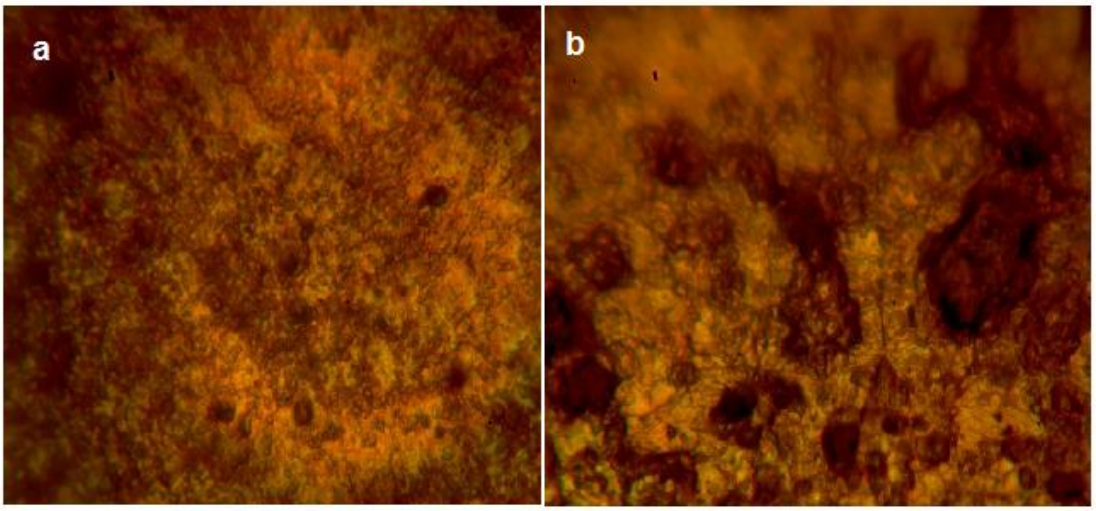

Figure 7. Microscopic images for PS films (a) before irradiation, (b) after irradiation.

4. Conclusions

The Schiff base was prepared and utilized as an additive to enhance the physicochemical characteristic of polystyrene. Polystyrene film containing Schiff base is

irradiated with ultraviolet radiation. An interesting association was observed between the physical and chemical properties of SEM, especially after irradiation.

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Conflicts of Interest

The authors declare no conflict of interest.

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