ISSN 2278-3091
Volume 8, No.1.3, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse2881.32019.pdf
https://doi.org/10.30534/ijatcse/2019/2881.32019

UV Exposure of the Surface Coating Sustainable Polymer Composite

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ABSTRACT

The expanding utilization of bright (UV) light in structures situations and even in shopper items requires that more prominent consideration be paid to the potential perils of this sort of electromagnetic radiation. The increasing use of natural resources has driven endeavors for the improvement of sustainable materials for different end-use applications. The use of renewable resources to substitute oil as the main feedstock for liquid fuels, chemicals and additive has encouraged studies to suggest the use of biopolymers. Renewable resources designed for agricultural products such as soya, palm oil, sunflower oil and coconut oil can be used for the production of polyols from fatty acid esters or fatty acids. All of these naturally occurring products are used in the chemical industry in many applications, especially for the manufacturing of biopolymers on construction surfaces where is the surfaces are most frequently subjected to climate circumstances rather than to external construction components. The suitable protective fillers were manufactured to block UV exposure as ultraviolet protection such as titanium dioxide (TiO2) to prevent negative impacts of exposure to this form of radiation. For surface coating applications, newly synthetic sustainable polymer composites of biopolymer based on waste cooking oil doped with TiO2 are function to avoid algae and moose attacks. Different load-ratio of TiO2 can be used in order to enhance material characteristics for outdoor practical use, in particular to enhance surface coating stability. The increase in the TiO2 filling content in the layers typically raises the refractive index of the layer at 2.329 according to the UV visible test. It is revealed by exposure to TiO2 coating on UV-B, the refractive index is desirable and it tends to boost the fabric surface energy, resulting in better functioning die to harm to the fabric under UV-B exposure.

Key words : Renewable resources, waste cooking oil, surface coating, UV visible test.

1. INTRODUCTION

Development in industry and population varieties has led in a huge rise in the manufacturing of countless kinds such as municipal solid waste. Many scientists have recently been drawn to the use of renewable resources by their ability to replace petrochemical derivatives. Renewable products consists primarily of five main plants, namely soybeans, palm oil, rapeseed, sunflower oil and coconut oil which synthesize materials under sunlight. The chemical industry processes these natural products and they are used in many areas of implementation particularly in the manufacturing of biopolymers [1]. Some scientists was explored epoxy oil acrylate resin from palm oil products, but its synthesized resin showed less curing characteristics in the application of radiation curable due to limited unsaturation of the palm oil fatty acid chain [2]. These resin performance was researched in terms of their curing rate and physical-mechanical characteristics of cured products under UV radiation [3].

Buildings are usually more vulnerable to environmental circumstances than other construction external components. With only a few exceptions, concrete membrane are not shielded by neighboring structures, but are usually fully exposed to wind, precipitation, changes in temperature and sunlight [4]. In order to avoid attacks by algae or moss, one of the alternatives is to introduce a photo catalyst as self-cleaning solution that is multifunctional for structures. Titanium dioxide is the most commonly used photo catalyst especially in its anatase type. A second phenomena called super hydrophilicity, in addition to the decomposition of organics. Dirt ions are normally gathered by waterfalls and rinsed off on a hydrophobic or water-repellent layer [5].

In this research, biopolymer from waste cooking oil was prepared and particular fabrication methods were developed and implemented to the substrates to generate viable plastic composites with distinct percentages of TiO2 as premier coating layer. Sustainable polymer composites with various percentages of TiO2 coating layer were subsequently subjected for eight weeks to sunlight and daily humidity. The UV reflective experiment was also performed to determine the refractive index of TiO2 filler in the coating.

2. METHODOLOGY

The monomer was produced using recycled cooking oil which was sourced locally from Industri Kecil dan Sederhana (IKS) and was chemically formulated at laboratory scale using less than 1L of waste cooking oil as claim in the Intellectual Property Protection PI 201000633; 2010/PT/TMI/PTA1.81/APP/0479/PCG on 30 DECEMBER 2010; “A Process of Fabricating Polymer Coated Lightweight Roof Tile”.

Table 1: Composites with various TiO2 percentages of biopolymer

Sample	Types of Coating	Biopolymer (gram)	MDI (gram)	TiO2 loading, (gram)
A	Uncoated surfaces	-	-	-
B	Coated biopolymer	1.0	0.5	-
C	Coated biopolymer 0.5% TiO_2	1.0	0.5	0.5
D	Coated biopolymer 1.0% TiO_2	1.0	0.5	1.0
E	Coated biopolymer 1.5% TiO_2	1.0	0.5	1.5
F	Coated biopolymer 2.0% TiO_2	1.0	0.5	2.0
G	Coated biopolymer 2.5% TiO_2	1.0	0.5	2.5

Characterized by two layers of polymer material on the surface of a rubberized concrete in which biopolymer, diisocyanate and TiO2 are mitigated in polymeric materials to generate a polymeric substance by weight of 1:0.5: 0.5-2.5 weight by weight with a polymeric material covered with thickness in the range of 0.30 to 0.35 mm. Unsaturated waste cooking oil (30 gm) added with water (50 ml). Ortho phosphoric acid (15 gm, 85% w/w) and hydrogen peroxide (18 ml, 30% w/w). The mixture was heated at 100ºC and stirred for 6 hours resulting in monomer sustainability.

The sustainable polymers composites which develop a superhydrophilic product such as TiO2 with a different of 0.5% until 2.5% were added in the biopolymer to produce a sustainable polymer composite that is suitable for coating the surfaces of concrete, glass, metal and other surfaces. Table 1 presents the appropriate biopolymer percentages: MDI: TiO2. The size of samples is 5 cm x 12 cm x 1.5 cm are shown in Fig.1 for exposure to outdoor according to ASTM 4597 – 05. The thickness was measured using Digimatic Vernier Caliper, model Mitutoyo.

Figure 1: Surface samples for outdoor exposure coated sustainable polymer composites

3. RESULTS AND ANALYSIS

Sustainable composites of TiO2 at different ratio of 0.5%, 1.0%, 1.5% 2.0% and 2.5% were exposed to sunlight and overnight moisture for a period of eight weeks as shown in Figure 2. Uncoated fabrics become hard as grain rises and the texture grows onto big cracks after subjected to sunlight and daily humidity, grain loosens, becomes slittered and pieces are broken off. The combination of light, water, mechanical forces and heat produced all these impacts. The observation of modifications in physical characteristics was evaluated in two classification; before and after sunlight exposure and overnight moisture. There is no physical changes, such as color change, sunburn, cracking, dusting, oily deposition and surface roughness at room temperature on uncoated or coated surfaces can be observed on unexposed surfaces, as indicated in Figure 2(a). In the meantime, the coated polymer composites of 0.5% tiO2 and 1.0% TiO2 color is dark-brown but has not shown a crack, sunburn, dirt, oily deposition or surface rawness increased on the exposed surface. The surface coating as shown to be light brown with 1.5% TiO2 and color changes cannot be observed in 2.0% TiO2 and 2.5% TiO2 for polymer composites. No crack, sunburns, dirt and oily deposition were shown in all specimens except surface roughness up to 2.5% TiO2 with smooth surface roughness.

Through this perception, it is proof that the various rates stacking of TiO2 can influence the surface covering execution which can shield the progressions of shading from crumbling upon natural presentation particularly with cruel tropical conditions. Alluding to Fig.2, it is proof that for the covered surface with polymer composites surface covering to 2.0% TiO2 balance out the surface property from solid central daylight, for example, burn from the sun, break, soil, sleek affidavit and surface harshness for the longer timeframe. Henceforth, improvement of the quality property for surface completing for open air application was watched. A longer time of introduction time ought to be proposed to further investigate the genuine impact of surface properties as referenced previously. Thee sustainable polymeric composites coating also developed a highly active photo catalytic and self-cleaning based on formulated using nanoparticles of TiO2 eliminates harmful molecules to improve a quality of its surfaces [6].

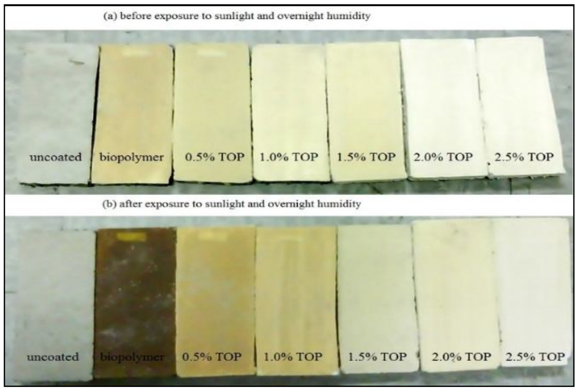

Figure 2: (a) before exposure to sunlight and overnight humidity (b) after exposure to sunlight and overnight humidity

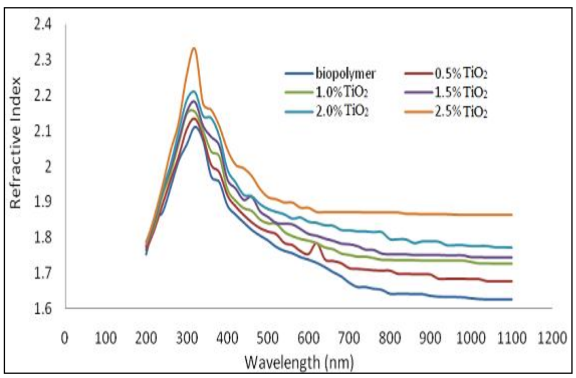

Figure 3: Refractive index vs. wavelength for unexposed TiO2 polymer composites surface coating

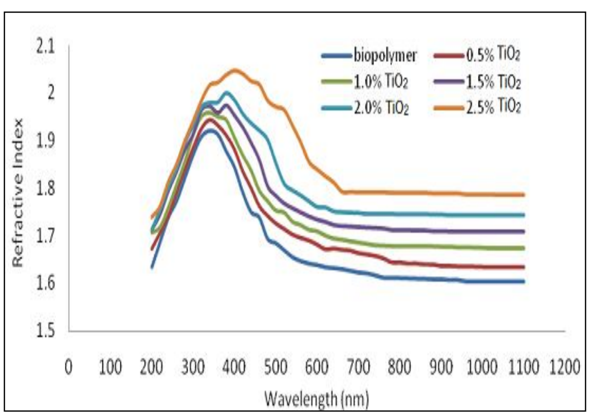

Figure 4: Refractive index vs. wavelength for exposed TiO2 polymer composites surface coating

The noticeable UV experiment relies on the dependency of the wavelength with any thin film layer. For two purpose, reflection and distribution rely on the wavelength of the incident light. First, for ideal single-wavelength results, thin coating is creates at a density of the design photon and the refractive index is suboptimal at any other wavelength. Second, the refractive index of the coating and substrates changes as a function of wavelength in term of spectrum. In this research, sustainable polymer composites may function as an anti-reflective coating that improves the effectiveness of environmental harm by increasing transmission and improving comparison with high potential for extensive use in indoor applications [7]. In order to determine their impact on sunlight exposure and the refractive index (RI) versus wavelength, sustainable polymer composites with distinct percentages of TiO2 were observed. Fig.3 and Fig.4 demonstrate the refractive index results versus wavelength for exposed and unexposed polymer composites with distinct percentages of TiO2. The effect of refractive index was combined in Fig.5 and Fig.6.

The change in wavelength before and after exposure is shown in Figure 5. Before exposure, some change in wavelength movement was observed and after exposure depends on the kinds of coating surfaces. A higher variation in the spectrum of visible portion from 320 nm to 400 nm is observed, followed by 1.5% TiO2 and 2.0% TiO2 between 320nm and 380nm, and about 18.75% and biopolymer, 0.5% TiO2 and 1.0% TiO2 from 320 nm to 400nm is about 6.25%. The movement from smaller wavelengths to longer wavelengths before and after exposure shows that UV-B radiation intake is optimized as the quantity of delocalization. Based on Figure 6, it demonstrated that a systematic increase in refractive index reactions was achieved as TiO2 percentages increased. The refractive index for unexposed polymeric composites is a systematic increase started with the refractive index 2.112, 2.134, 2.155, 2.181, 2.209 and 2.329, respectively. The refractive index decreased at exposure by 0.5%, 1.0%, 1.5%, 2.0% and 2.5% TiO2 at refractive index 1.9197, 1.944, 1.9581, 1.974, 1.999 and 2.0461, respectively.

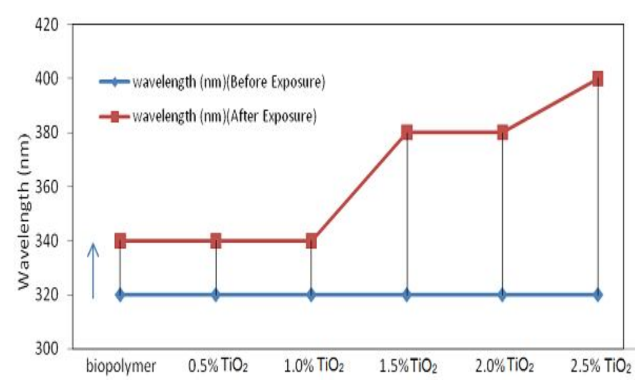

Figure 5: The changing wavelength of UV visible test before and after sunlight exposure for polymer composites with different percentages of TiO2.

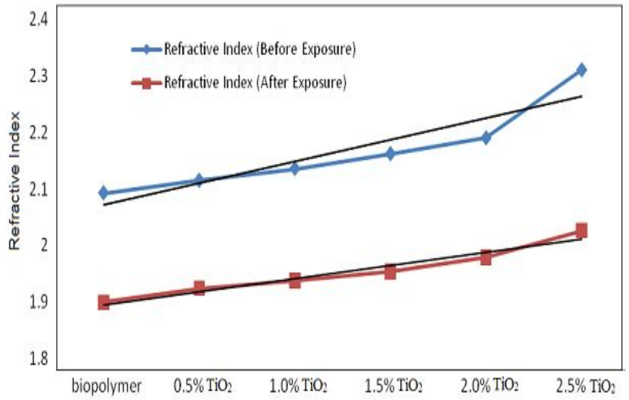

Figure 6: Refractive index before and after sunlight exposure for polymer composites with different percentages of TiO2.

The refractive index of TiO2-coated polymer composites usually depends on the TiO2 coating layer proportion. Increasing the material of TiO2 filler in the coats typically improves the refractive index. It is shown that when exposed to TiO2 material on the UV-B, it is necessary to raise the refractive index and continues to boost the surface energy of the layer, which can lead in greater functionality from harm to the better when exposed to UV-B radiation.

The UV-blocking feature system of inorganic metals doped with TiO2 offers excellent UV protection by reflecting or scattering through its elevated refractive index most UV rays. Although long-wavelength UV erythermal risk is smaller than short-wavelength UV, the former penetrates closer into the layer and has a build-up impact on the group. Thus, TiO2 is used as a solar UV blocker; certain methods for stronger UV protection should be implemented.

4. CONCLUSION

To conclude, distinct TiO2 ratio loading can be used to enhance material characteristics in practical use for indoor applications, especially to enhance surface layer strength. The serious tropical ecological presentation test at specific occasions revealed that biopolymer doped with just 2.5% TiO2 from sustainable assets exhibits no confirmation of adjustments in shading or surface properties, for example, burn from the sun, break, dust, sleek affidavit and surface harshness. The states of the superhydrophobic surfaces transform into a higher water contact point up to 150° especially after UV light exhibit the magnificent capability of the rear introduction for define suitable polymeric composite layer of such developments with smooth dainty layer keeps up itself free of residue and growths.

The refractive index of TiO2-coated polymer composites usually depends on the TiO2-coating layer proportion. The increase in TiO2 filler in layers usually raises the coating's refractive index. When exposure to the TiO2, the refractive index can be increased and the surface energy of the covering can be increased, which can lead to stronger functioning of harm caused by the layer under UV-B radiation pressure. Thus, TiO2 can assist to enhance surface performance and stabilization for indoor or construction applications by using polymer coating.

ACKNOWLEDGEMENT

The author would like to thanks the Universiti Tun Hussein Onn Malaysia and the Malaysian government for financed this research under GPPS Grantt vot H339 & H341 and Contract Grantt H464.

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