Al-Nahrain Journal of Science
ANJS, Vol.25 (4), December, 2022, pp. 11-15

The Use of Combination of Clarithromycin -Nano Oxide Nanoparticles to Doping PVC to Protect it from Photodegradation

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Article's Information

Received:
01.11.2022
Accepted:
27.12.2022
Published:
31.12.2022

Keywords:
PVC
Nano oxide
UV light
Clarithromycin

Abstract

Films of polyvinyl chloride with oxide nanoparticles (MgO, NiO, TiO_2, and ZnO) and clarithromycin were prepared. Oxide nanoparticles were used in low concentrations (0.01% by weight) along with clarithromycin. The analysis of oxide nanoparticles and clarithromycin as UV blockers for PVC photodegradation investigations into weight loss, surface morphology, and IR changes, revealed that titanium oxide, especially, protects PVC from harmful ultraviolet light.

DOI: 10.22401/ANJS.25.4.02
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1. Introduction

Plastics are used for different purposes they have many features (strong, moldable, and can be colored). They are utilized as a replacement for construction materials (wood, metals, ceramics). Polyvinyl chloride (PVC) has many features such as weathering resistance, electrical isolation, acoustic insulation, low cost, etc. It can be used in construction materials, equipment of office, electronics, some components of automobiles, medical purposes, cables, and connections [1].

PVC has different applications but a high content of chlorine is a problem cause dangerous waste for the environment. physical and chemical changes happen when poly (vinyl chloride) exposure to temperatures and UV light with an excess of oxygen [2].

The oxidative reaction leads to the splitting of the chains and small fragments are formed which degrade the material. Sunlight causes the photodegradation of poly (vinyl chloride) and polymers. The properties and functioning of polymers are altered in a number of different ways as a result of photodegradation [3]. In order to lengthen the useful life of polymers, it is essential to increase the resistance of PVC to ultraviolet light and bring down its rate of photodegradation photo stabilizers (plasticizers, pigments, and UV absorbers) are blended with polymers to protect them from light, especially ultraviolet irradiation. several organometallics including clarithromycin complexes use as photo stabilizers for polymers. In this work clarithromycin (Figure 1) is utilized as a stabilizer, and nano oxides [4] are utilized with clarithromycin to test their impact on the degradation of PVC.

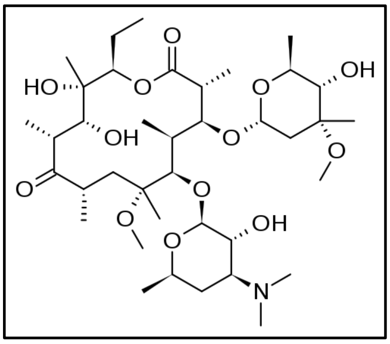

Figure 1. Shows the structure of clarithromycin.

2. Experimental

2.1 Films fabrication:

Films of PVC were prepared by casting method by Using (1 gm) from PVC, (25 gm) clarithromycin, and 0.5 mg of metal oxide nanoparticles (MgO, TiO_2, ZnO, and NiO) [5,6] with 100 ml from tetrahydrofuran were stirred for 60 min. sonicated the mixture for 60 min to take out the bubbles and cast it by glass templates and left the THF to vaporize at room temperature for one day. The films were lifted from the template and then kept at room temperature.

2.2 Effect exposure the films to ultraviolet:

The films were exposed to ultraviolet light with a maximum wavelength of 365 nm and an intensity of 6.0×10^{-9} ein.dm^{-3}. The films were turned around every so often to make sure that all of them got the same amount of UV light. The time of irradiation was 50, 100, 150, 200, 250, and 300 hours [7].

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3. Results and Discussion

3.1 Utilizing FTIR spectroscopy to study photostability:

The films were put in ultraviolet light, and FTIR spectroscopy was used to see how the additive affected the PVC's ability to stay stable in light. When oxygen is present and UV light hits PVC, ketone and polyene are made. The intensities of the bands C=C (alkenes; 1600 cm^{-1}) and C=O (ketones; 1730 cm^{-1}) were observed during irradiation and were compared with a standard peak (1328 cm^{-1}) [8].

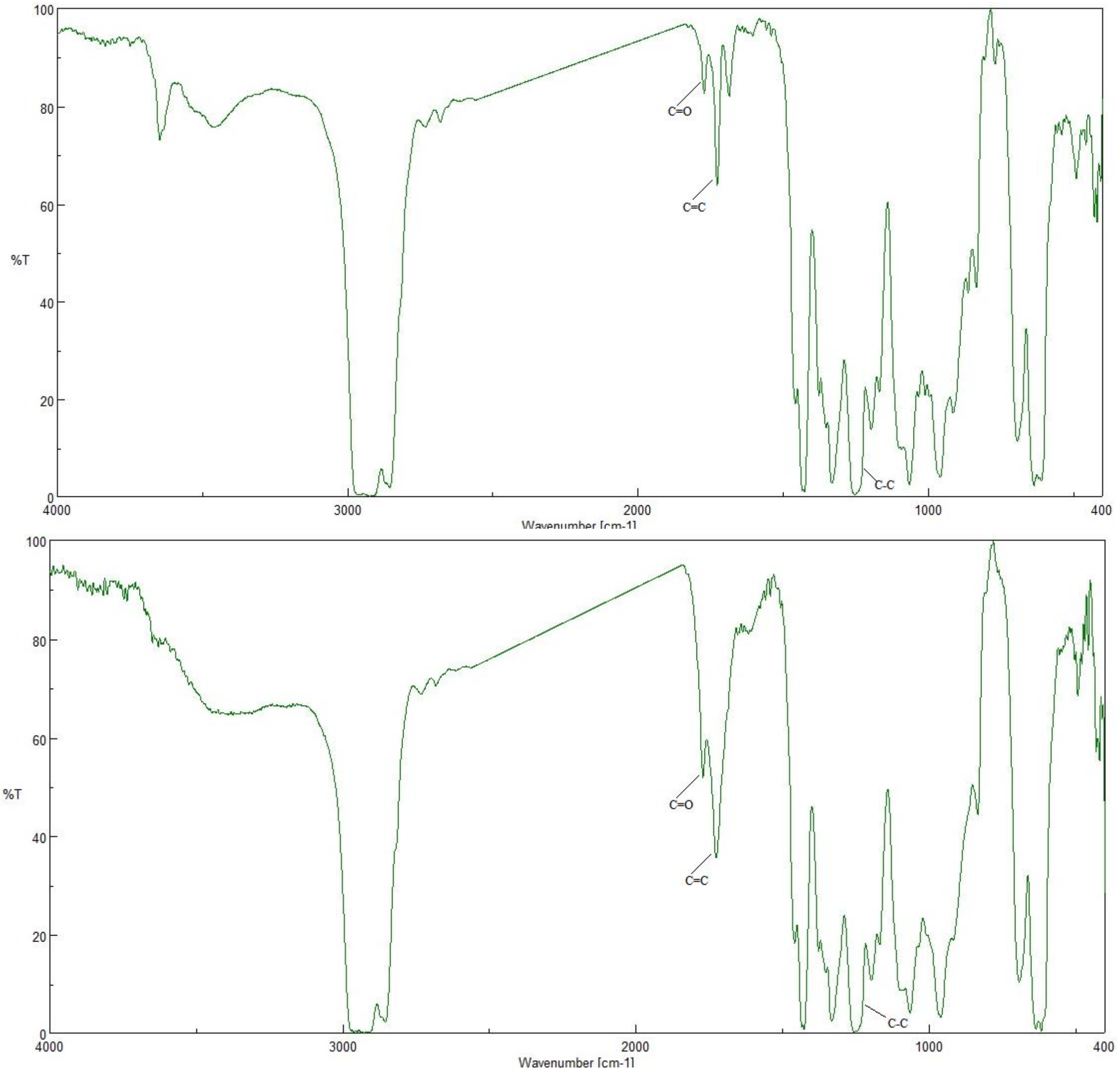

Figure 2. Shows the intensities of the bands C=C and C=O.

To calculate the index of C=C and C=O was used equation (1). The absorption of both C=O and C=C (*As*) and for standard peak (A_r) were utilized to calculate Is. $I_{C=O}$ and $I_{C=C}$ were calculated for different irradiation times (50, 100, 150, 200, 250, 300)

$$Is\frac{As}{Ar} \quad \ldots(1)$$

The addition of clarithromycin-metal oxide led to a notable reduction in the index of $I_{C=O}$, $I_{C=C}$ which means the additives reduce schisms of the polymer chain and formation fragments that contain carbonyl and polyene groups [9,10].

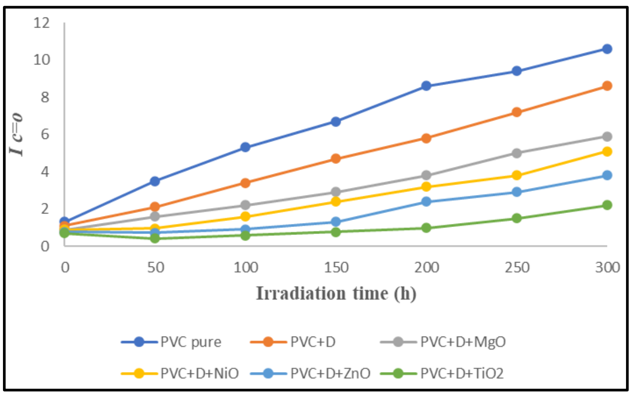

Figure 3. Shows the relationship between $I_{C=O}$ index and irradiation time.

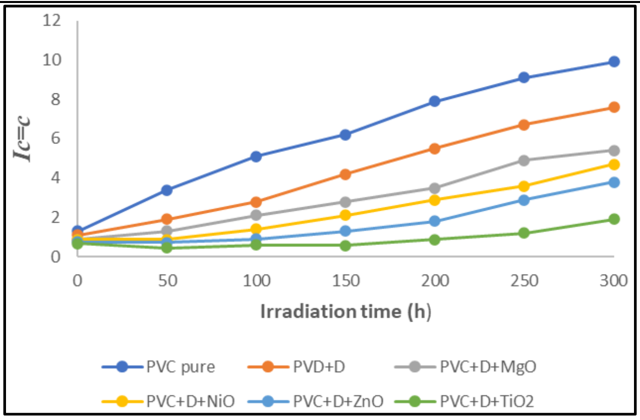

Figure 4. Shows the relationship between $I_{C=O}$ index and irradiation time.

3.2 Utilizing Weight Loss to study photostability:

The cross-linking and free radicals formed when PVC exposure to photodegradation and Photooxidation. The weight of PVC blank and PVC with additives was measured before irradiation (W_0) and after irradiation (W_t), Equation (2) was used to estimate the percentage of the weight loss [11].

$$\text{weight loss }\% = \frac{W_0 - W_t}{W_0} \times 100 \qquad \ldots(2)$$

The highest percentage loss of weight was in pure PVC. while the additives reduced weight loss notably.

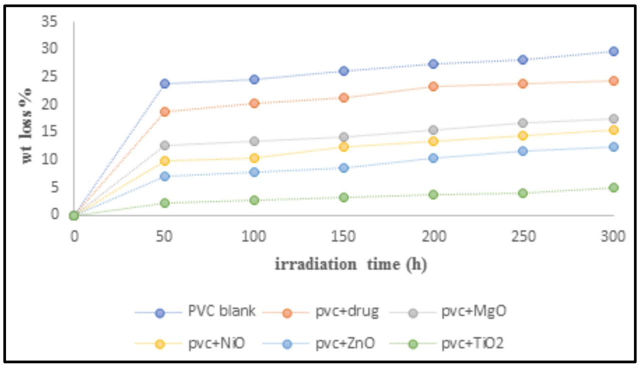

Figure 5. Shows the percentage loss of weight of PVC films.

3.3 Utilizing molecular weight to study photostability:

There is a reversible relation between molecular weight (Mv) and time of irradiation. Photodegradation of PVC leads to breaking the bond and decreased molecular weight. The decrease in PVC molecular weight with additives was much less compared with the PVC blank. The reduction of molecular weight could be estimated by equation (3) [12]

$$[\eta] = 1.38 \times 10^{-2}\, M_v^{0.77} \qquad \ldots(3)$$

3.4 Effect of irradiation on surface morphology of films:

After UV exposure, the film's surface can be examined under an optical microscope to reveal any deformations, cracks, dark patches, or chain-scission. Dehydrochlorination is the main reason why the surface of an irradiated PVC film breaks down [13]. In contrast to the surface that has been irradiated, which has cracks, spots, and other irregularities, the surface of pure PVC that has not been irradiated is usually uniform and does not have any cracks or spots. Figure 6 shows pictures (400x magnification) taken with a microscope of pure PVC film and PVC that has been exposed to radiation for 300 hours and mixed with additives [14]. When the pure PVC film was exposed to radiation, cracks, spots, and changes in color showed that the surface was breaking down more quickly [15].

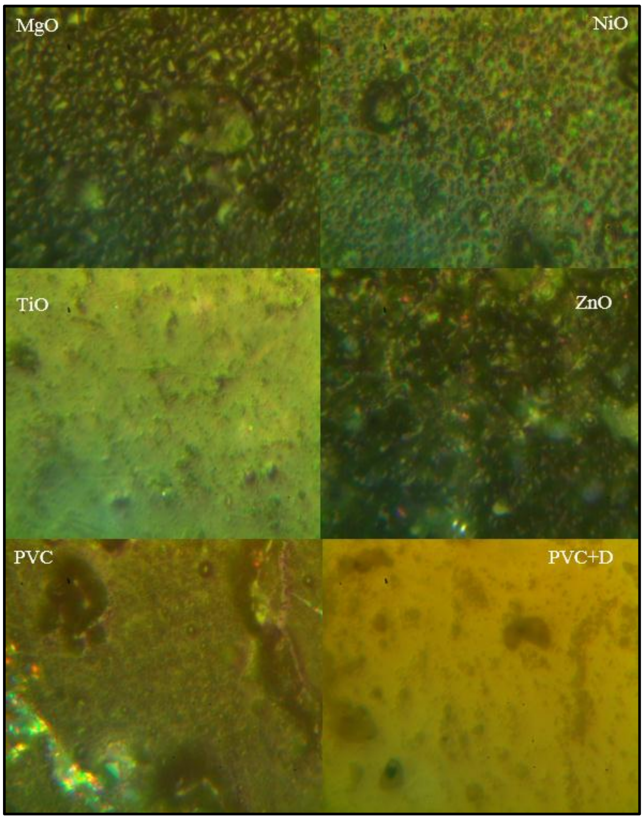

Figure 6. Shows microscopic images of blank PVC film, PCV with additives before irradiation.

Also, SEM was used to study the damage on the films. The SEM technique gives images containing information about homogeneity [16], spots, cracks, size, and shape of particles. Photodegradation leads to formed spots, grooves, and irregular nanoparticles [17].

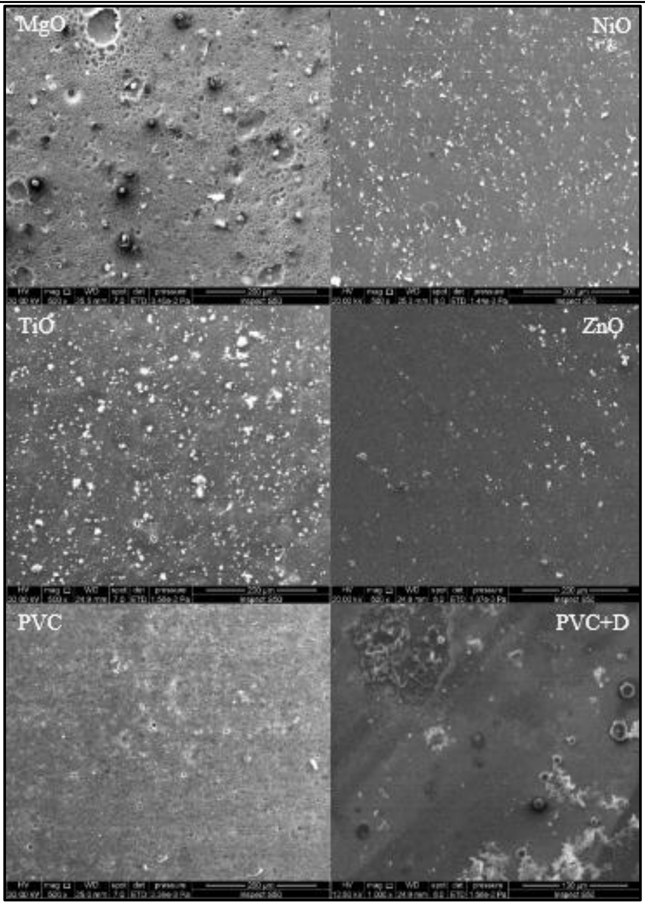

Figure 7. Shows SEM images of PVC film with additives after irradiation for 300 hours.

Another technique in the study of polymer surfaces is atomic force microscopy (AFM). The roughness degree and dark spots in the film depend on the additives type. irradiated blank PVC film shows a high roughness, heterogeneity, and a high number of spots compared with films that have additives [18]. using clarithromycin and metal oxides lead to a decrease in the factor of roughness. The additives protected the PVC films [19,20].

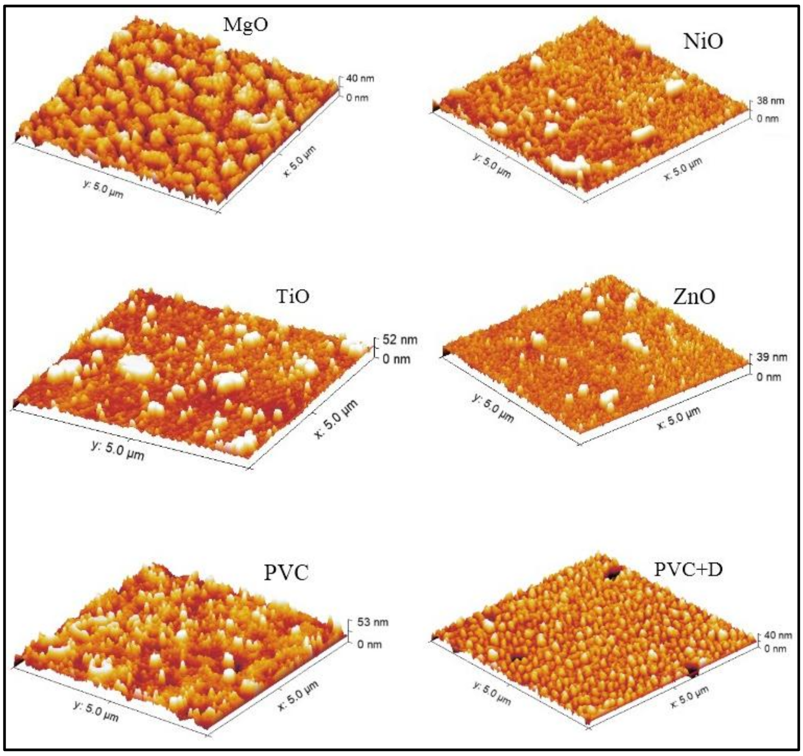

Figure 7. Shows SEM images of PVC film with additives after irradiation for 300 hours.

4. Conclusions

A combination of metal oxide and clarithromycin was utilized to lessen the effects of UV radiation damage. In comparison to films alone, changes in weight, infrared spectra, and surface morphology were smaller when additives were present. The additives act as absorbers of ultraviolet rays that damage the polymer surface and convert these rays into heat.

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