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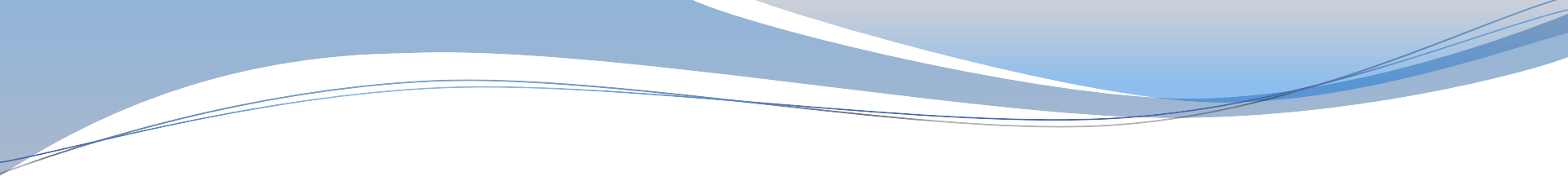
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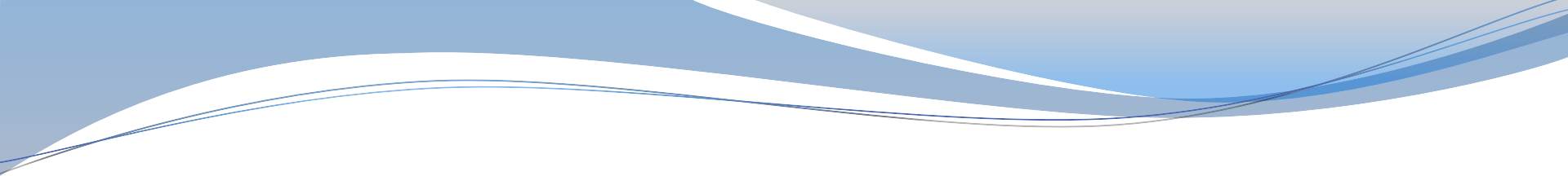
Organotin complexes as photostabilizer for PVC

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Exposure to ultraviolet (UV) radiation may cause the significant degradation of many materials. UV radiation causes photooxidative degradation which results in breaking of the polymer chains, produces free radical and reduces the molecular weight, causing deterioration of mechanical properties and leading to useless materials, after an unpredictable time.

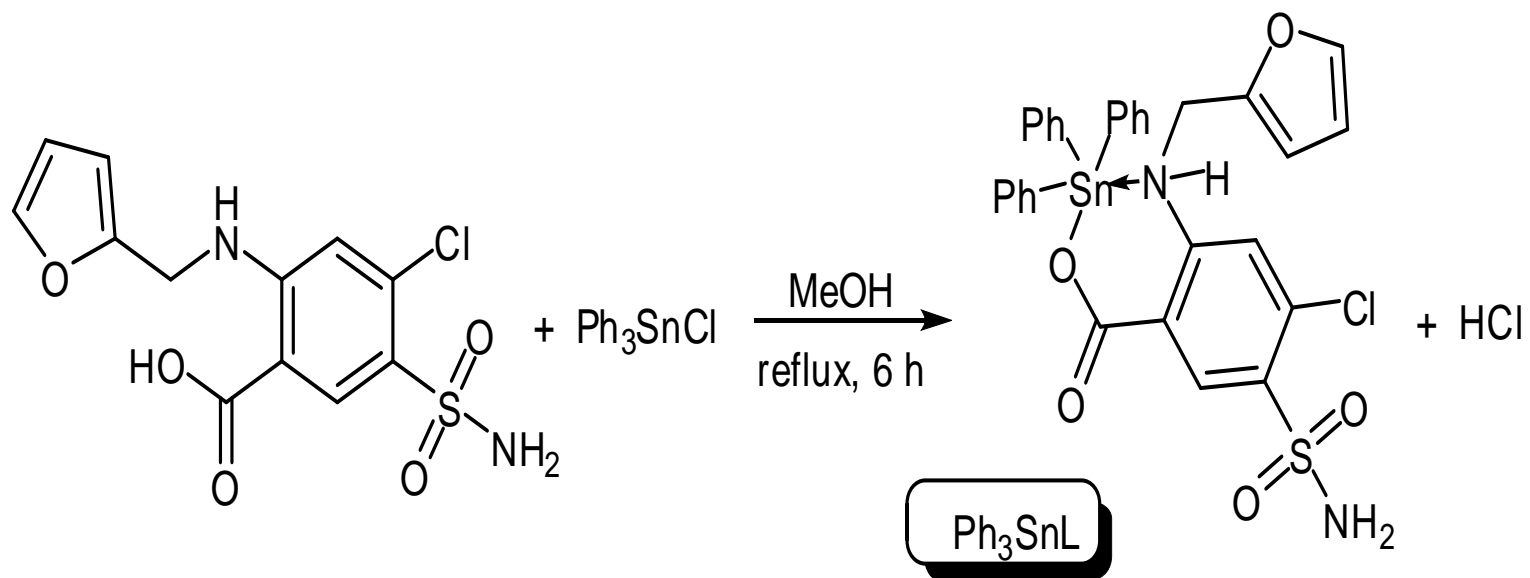


It is necessary to find a means to reduce or prevent damage induced by environmental components such as heat, light or oxygen. The photostabilization of polymers may be achieved in many ways. The following stabilizing systems have been developed, which depend on the action of stabilizer: (1) light screeners, (2) UV absorbers, (3) excited-state quenchers, (4) peroxide decomposers, and (5) free radical scavengers.

Aim of the work

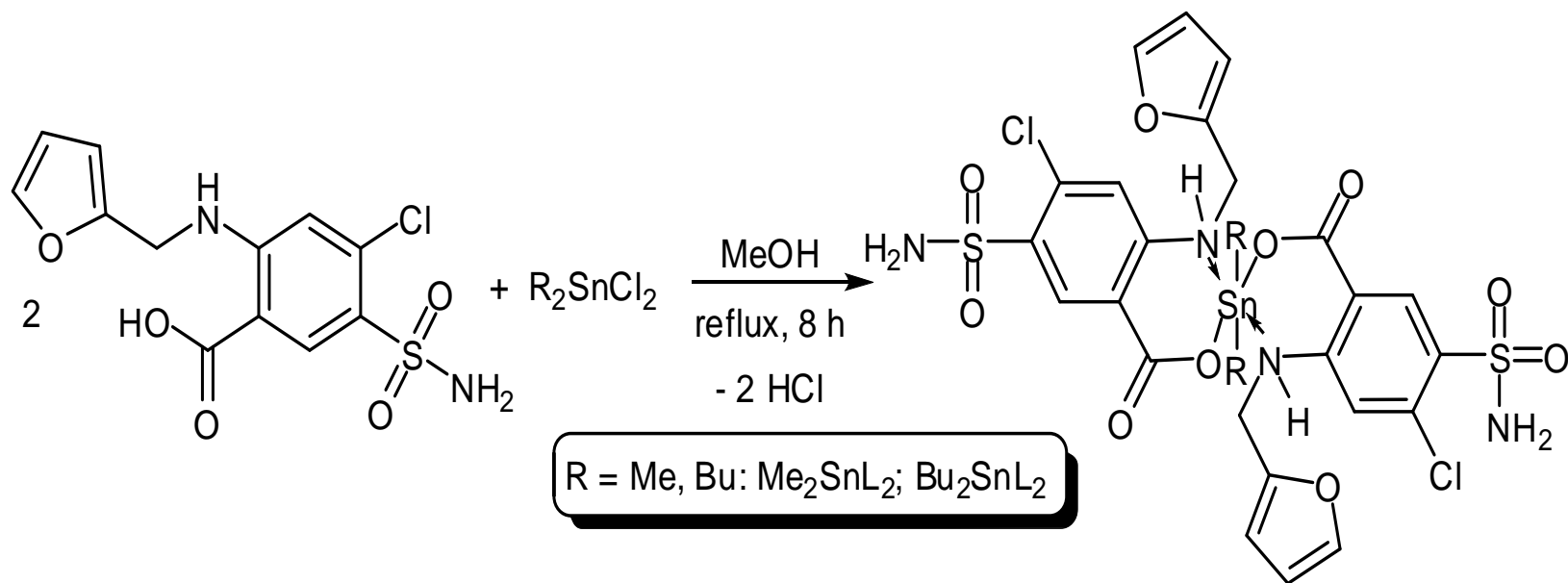
- i- Synthesis and characterization of Di- and Triorganotin(IV) complexes with furosemide as a ligand.
- ii- Evaluation the photostabilization activity of these organotin(IV) complexes against photodegradation of poly(vinyl chloride) polymer.

Synthesis of triorganotin(IV) complex :



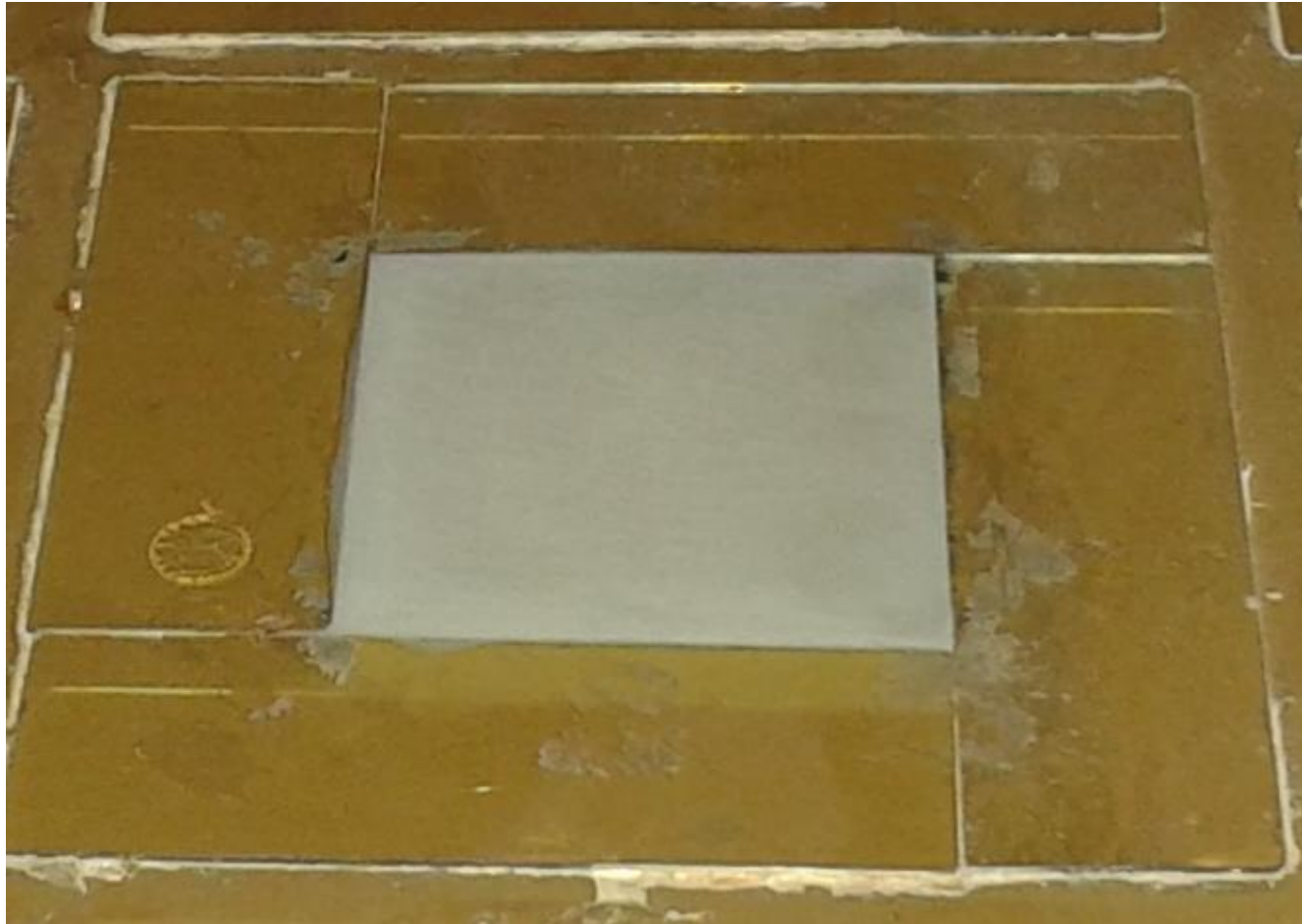
Scheme 1. Synthesis of triphenyltin (Ph_3SnL) complex.

Synthesis of diorganotin(IV) complexes :

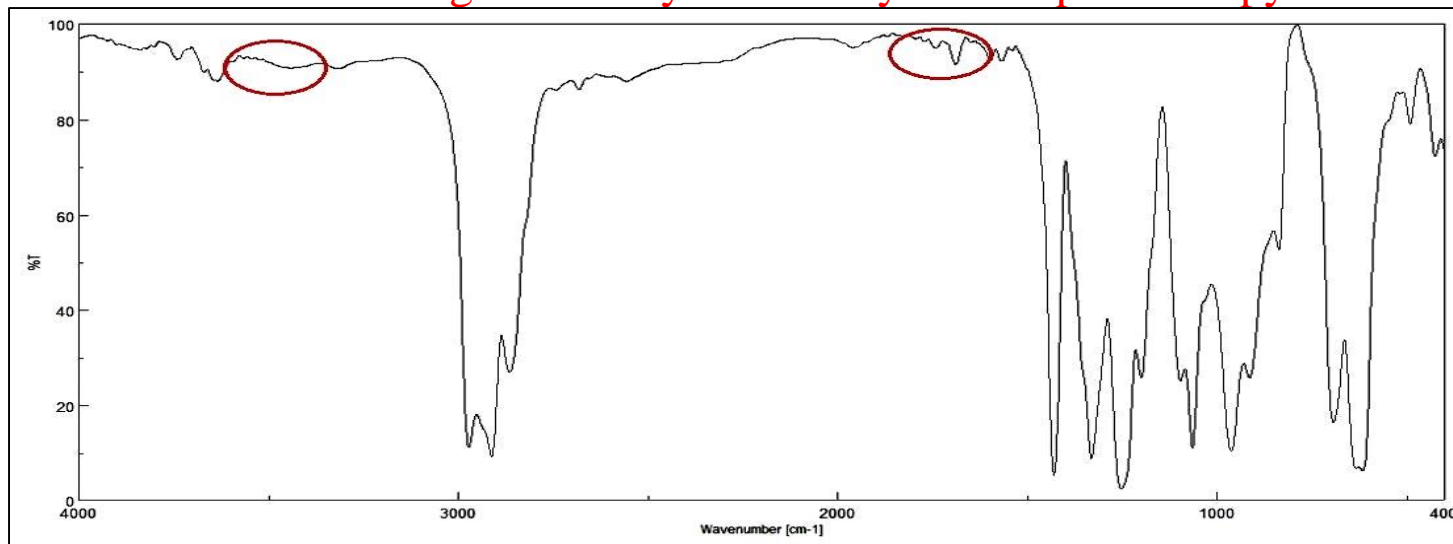


Scheme 2. Synthesis of dimethyltin (Me_2SnL_2) and dibutyltin (Bu_2SnL_2) complexes.

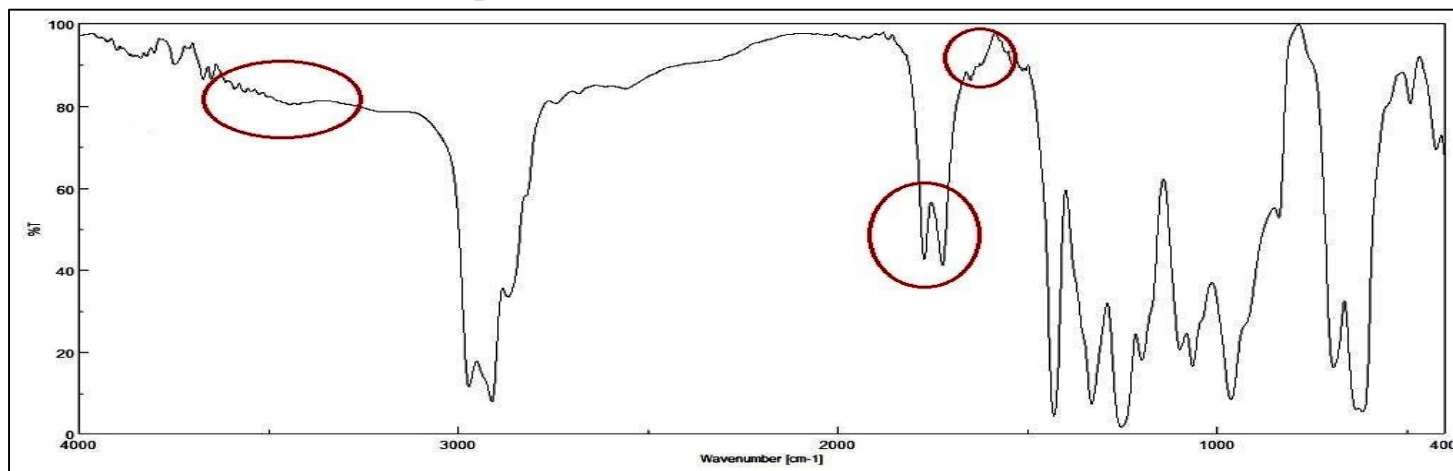
PVC Film



Evaluation of Stabilizing Efficiency of PVC by FTIR Spectroscopy

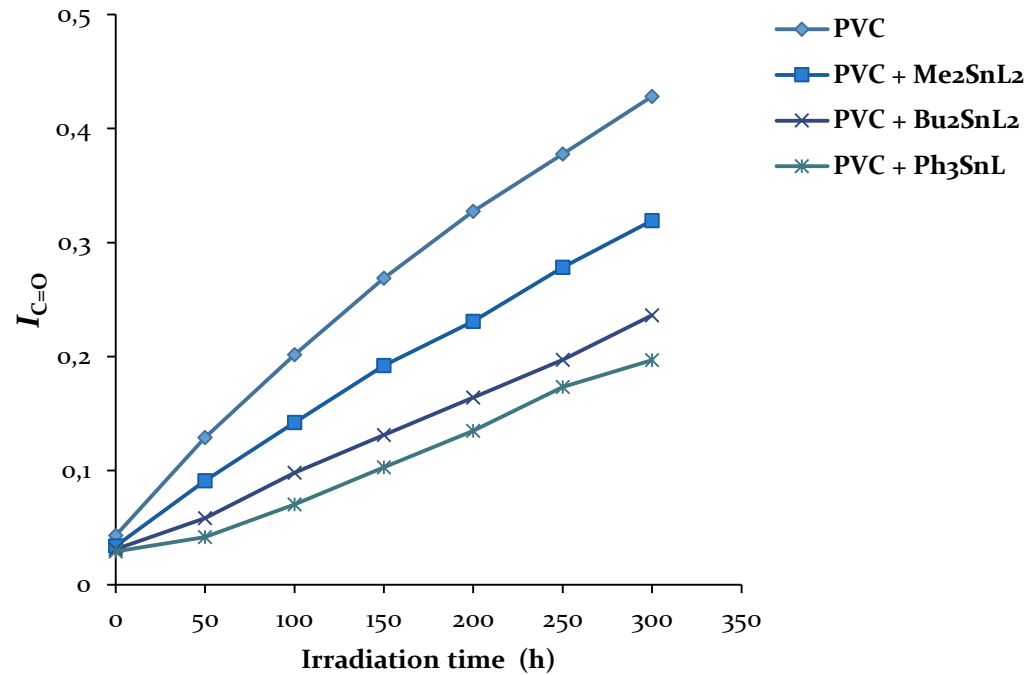


FTIR spectrum of PVC (control) film before irradiation.

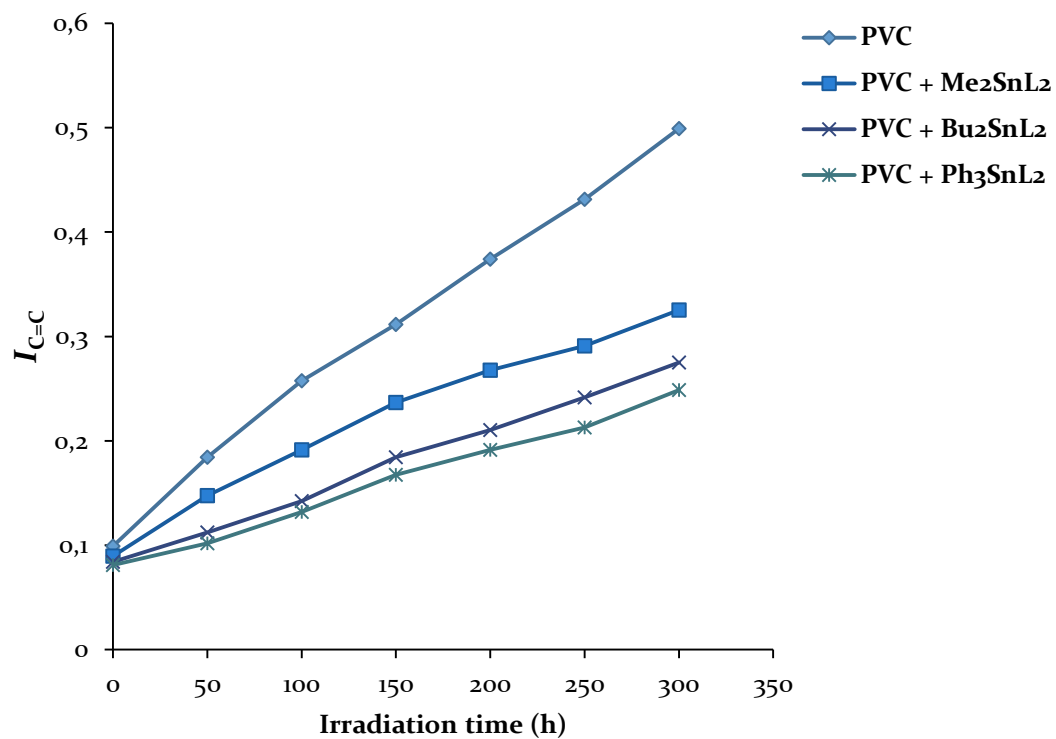


FTIR spectrum of PVC (control) film after 300h of irradiation.

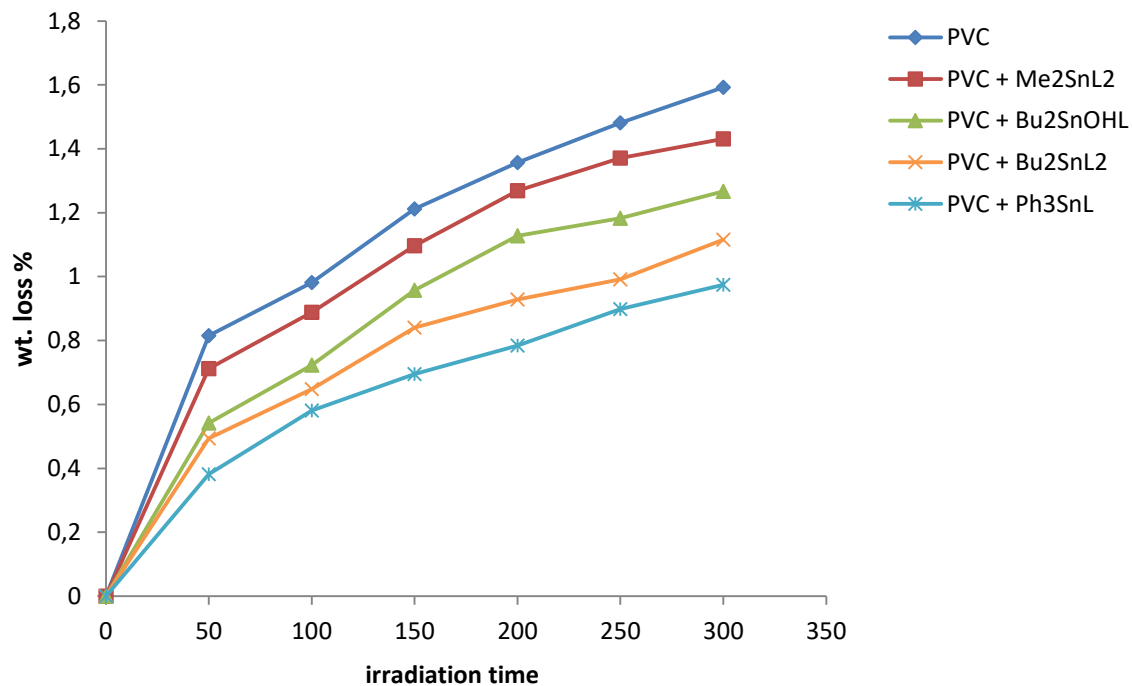
Changes in the $I_{C=O}$ index for PVC films versus irradiation time.



Changes in the $I_{C=C}$ index for PVC films versus irradiation time.

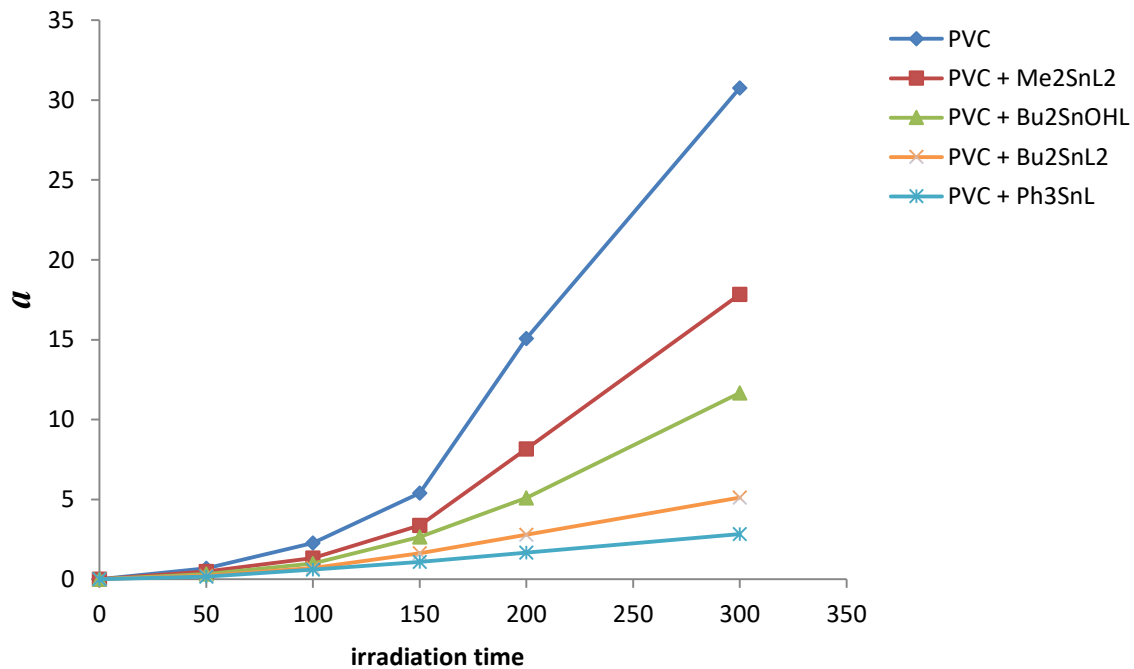


Evaluation of Stabilizing Efficiency of PVC by Weight Loss



Changes in weight loss of PVC films versus irradiation time.

$$\alpha = M_{V,0} \times S / \bar{M}_{V,t}$$



Changes in the degree of deterioration (α) for PVC films versus irradiation time.

Quantum yield

The quantum yield of main chain scission (Φ_{cs}) is dependent on intrinsic viscosity of PVC before irradiation (η_o), irradiation time (t), incident intensity (I_o), $\bar{M}_{V,O}$, concentration (C) and Avogadro's number (A). The Φ_{cs} was calculated using following Equation.

$$\Phi_{CS} = (CA/\bar{M}_{V,O}) \left[([\eta_o]/[\eta])^{1/\alpha} - 1 \right]$$

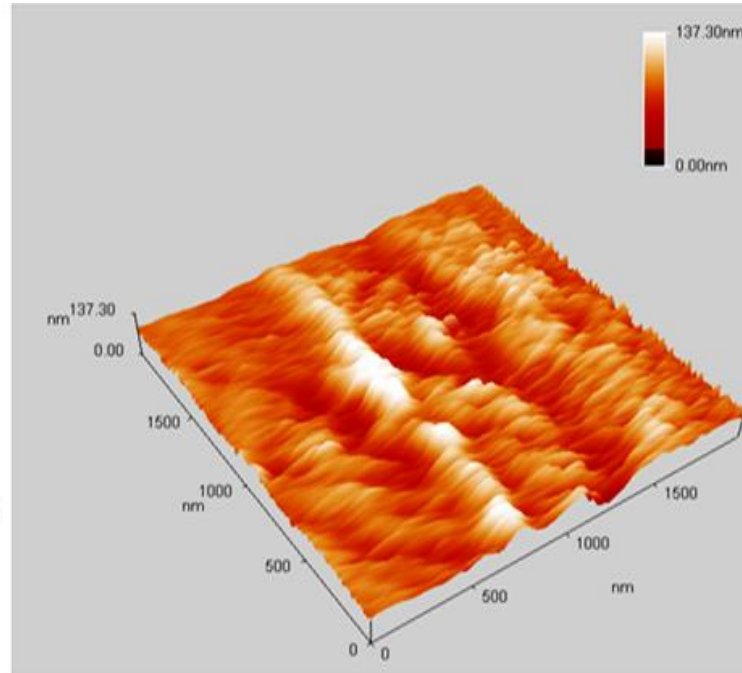
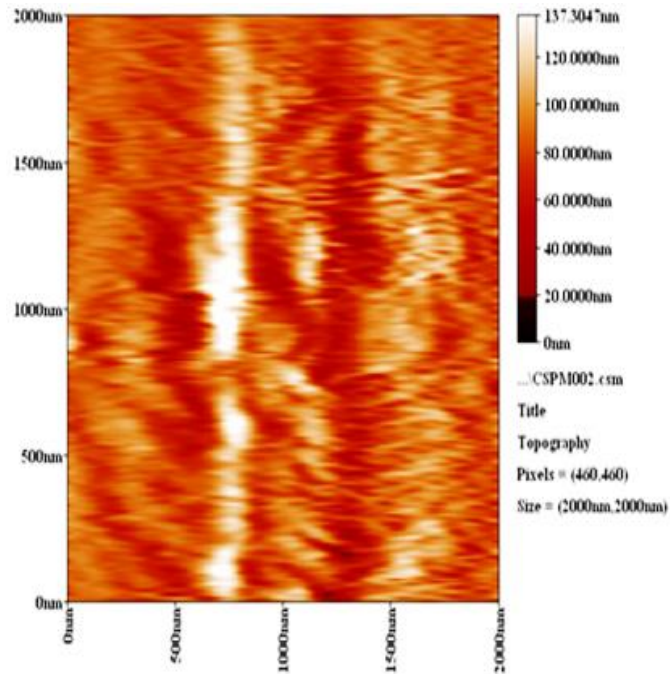
Compound	Quantum Yield of Main Chain Scission (Φ_{cs})
PVC (control)	5.18×10^{-6}
PVC + Me_2SnL_2	3.79×10^{-6}
PVC + Bu_2SnOHL	2.95×10^{-6}
PVC + Bu_2SnL_2	1.58×10^{-6}
PVC + Ph_3SnL	9.8×10^{-7}

Table 5. Quantum yield (Φ_{cs}) for the chain scission for PVC film (40 μ m) containing metal complexes (0.5 wt %) after irradiation (300 h).

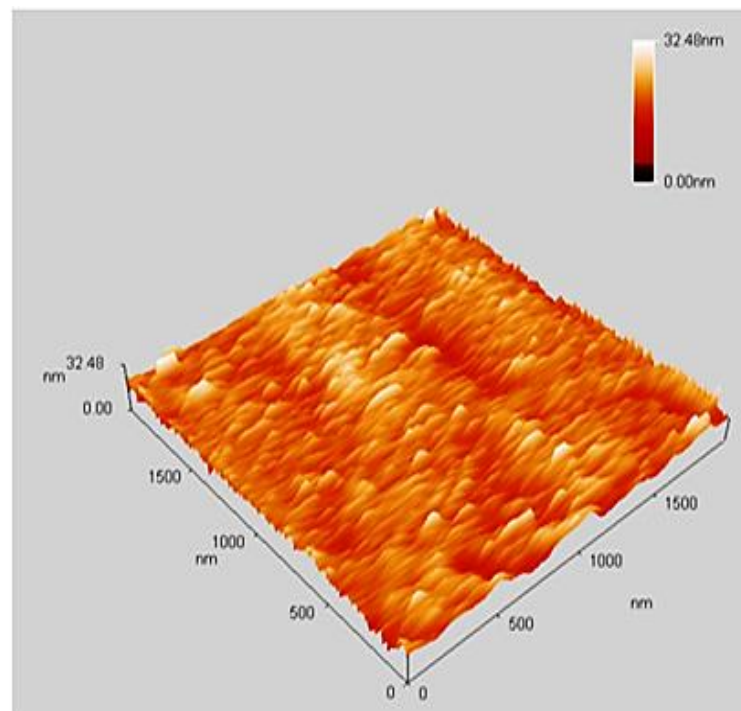
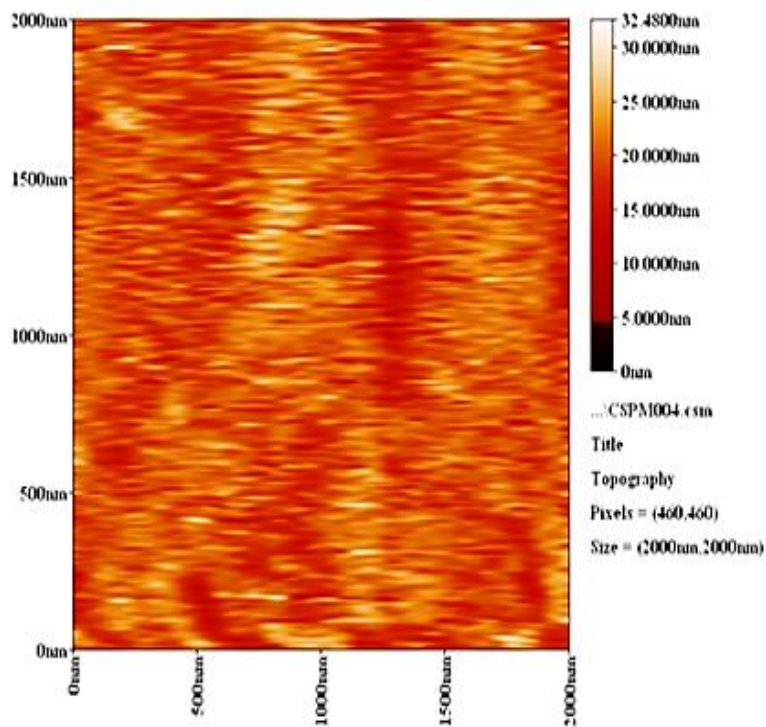
Surface Analysis

The morphology of PVC surface was inspected using an atomic force microscope (AFM). It provides two- and three-dimensional topographic images of the PVC surface on irradiation (300 h). AFM is helpful to measure the pores size and roughness factor (R_q) of the PVC film.

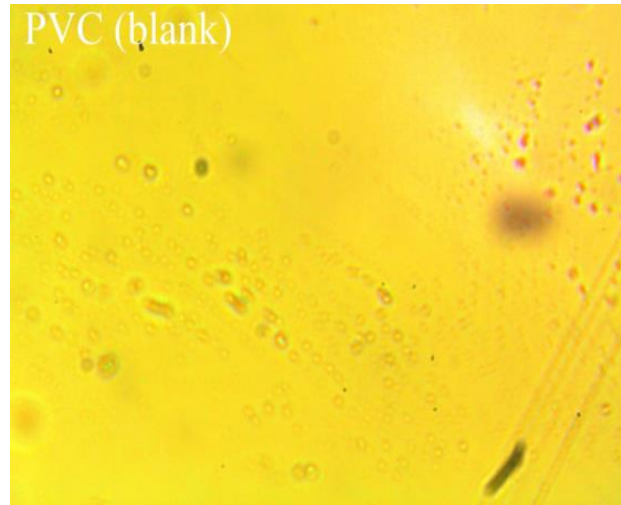
The surface of **PVC film containing Ph_3SnL** after irradiation was very smooth ($R_q = 2.61$). In contrast, the **blank PVC** film after irradiation has a rough surface ($R_q = 17.3$). UV irradiation may have led to bond breakage within polymeric chains and hence the removal of leachable constituents from the PVC surface which can result in a roughened surface



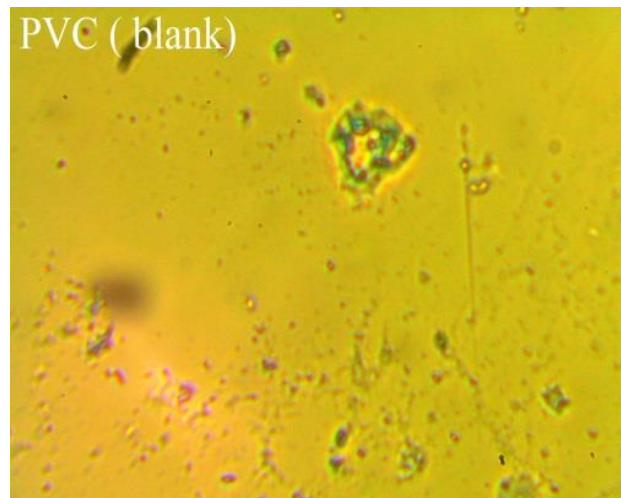
AFM images for PVC film (control) after irradiation (300 h).



AFM images for PVC film containing Ph_3SnL complex after irradiation (300 h).

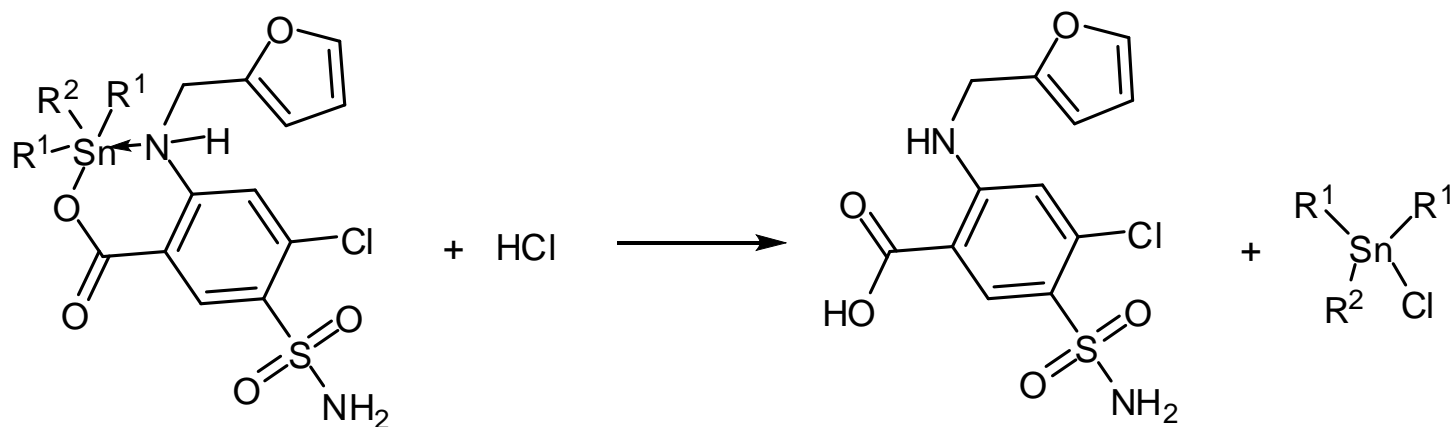


Microscope images for the non-irradiated PVC films (40 μm thickness)



Microscope images for the irradiated (300 h) PVC films (40 μm thickness)

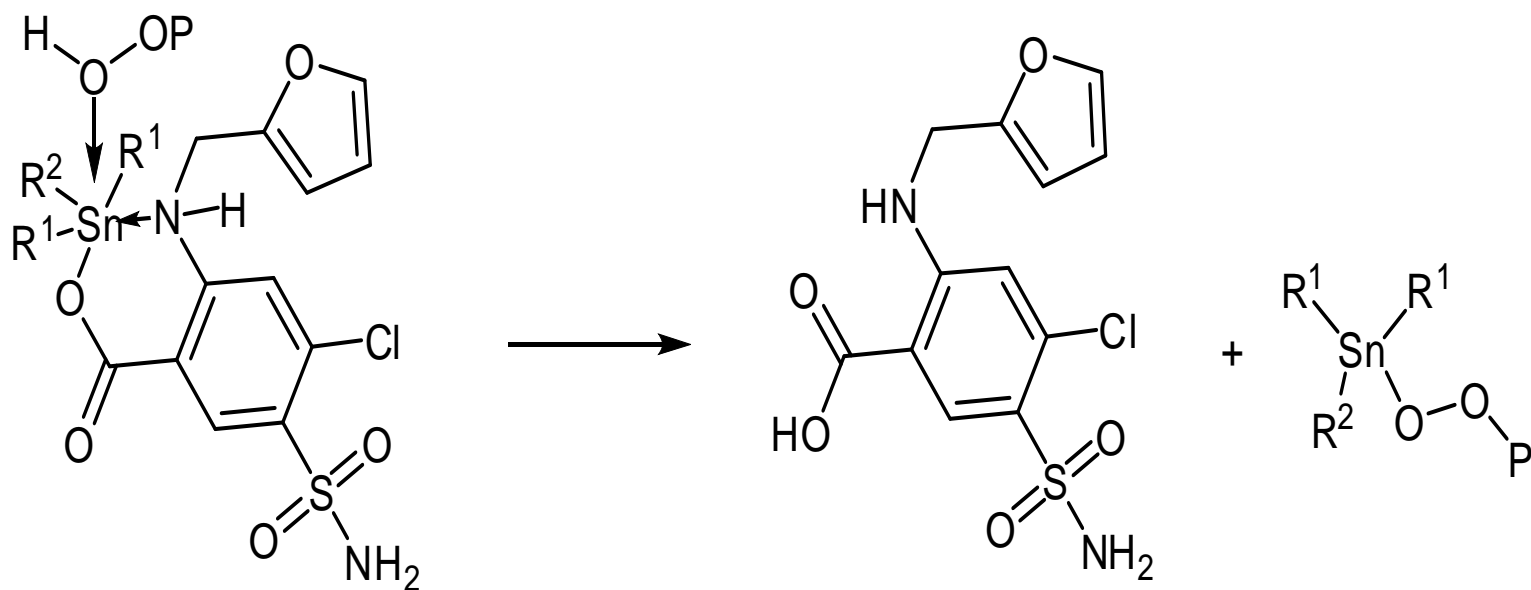
Suggested Mechanisms of Photostabilization of PVC:



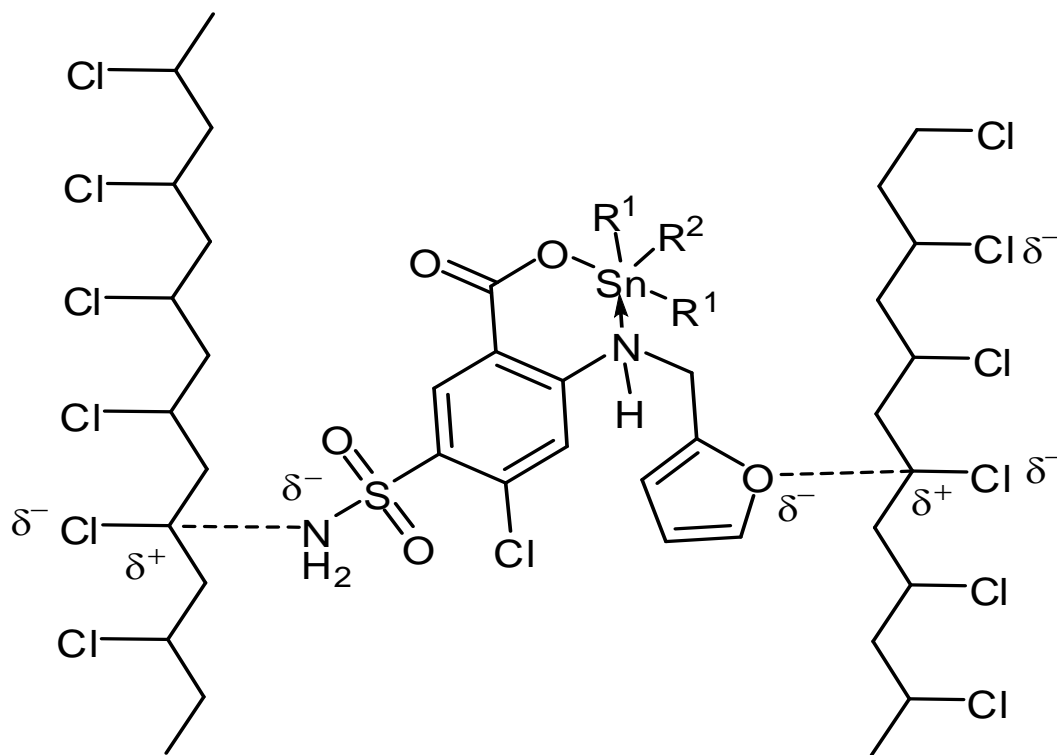
R¹ = Ph, Me, Bu

R² = Ph, 4-chloro-2-(furan-2-ylmethylamino)-5-sulfamoylbenzoate

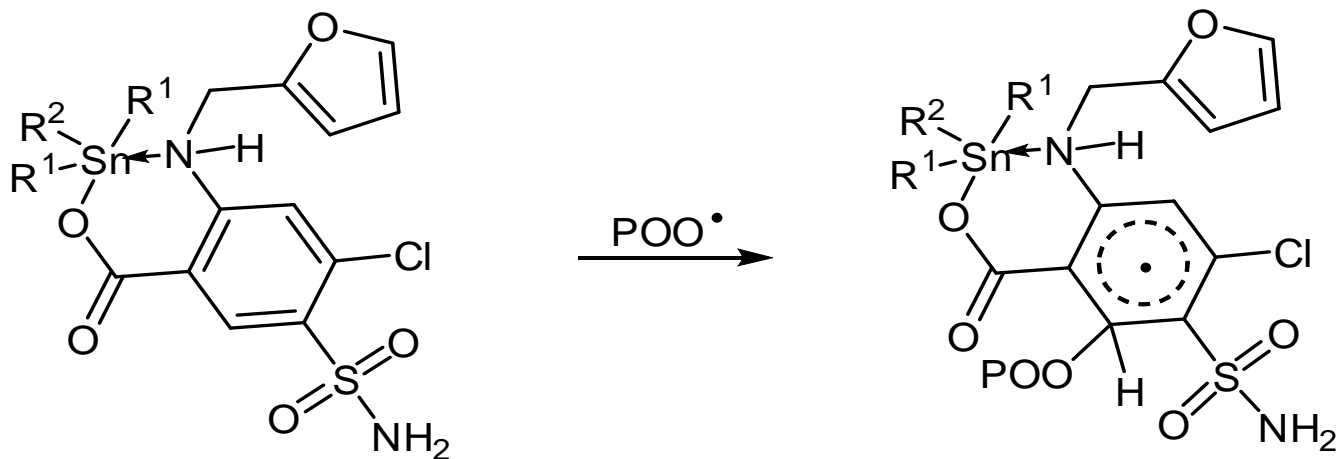
Scheme 4. Organotin complexes act as HCl scavengers.



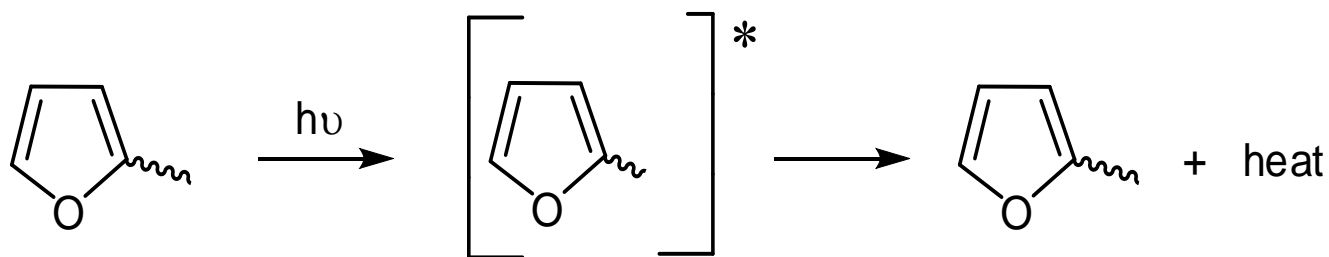
Scheme 5. Organotin complexes as peroxide decomposers.



Scheme 6. Organotin complexes as primary stabilizers.



Scheme 7. Organotin complexes as radical scavengers.



Scheme 8. Furan moiety acts as a UV absorber.

Conclusions:

1. Organotin additives used in this study behave successfully as **photostabilizers** for PVC films.
2. The additives take the following order in photostabilization activity According to their decrease in **carbonyl, hydroxyl, polyene** ($I_{C=O}$, I_{OH} , $I_{c=c}$) and the **weight loss** for PVC films.



3. These additives stabilize the PVC films through **HCl scavenging, peroxide decomposers, primary stabilizers, free radical scavenger and UV absorber mechanisms.**

Article

Photostabilizing Efficiency of Poly(vinyl chloride) in the Presence of Organotin(IV) Complexes as Photostabilizers

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