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## ORIGINAL ARTICLE

# New stabilizers for PVC based on some diorganotin(IV) complexes with benzamidoleucine

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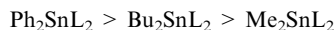
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Received 15 December 2011; accepted 13 March 2012

## KEYWORDS

Photostabilizer;  
PVC;  
Diorganotin(IV);  
Benzamidoleucine;  
Quantum yield;  
HCl scavenging

**Abstract** The photostabilization of poly(vinyl chloride) (PVC) films by diorganotin(IV) complexes of the type  $\text{Ph}_2\text{SnL}_2$ ,  $\text{Bu}_2\text{SnL}_2$  and  $\text{Me}_2\text{SnL}_2$  of the ligand benzamidoleucine complexes was investigated. The PVC films containing concentration of complexes 0.5% by weight were produced by the casting method from tetrahydrofuran (THF) solvent. The photostabilization activities of these compounds were determined by monitoring the carbonyl, polyene and hydroxyl indices with irradiation time. The changes in viscosity average molecular weight of PVC with irradiation time were also tracked (using THF as a solvent). The quantum yield of the chain scission ( $\Phi_{\text{cs}}$ ) of these complexes in PVC films was evaluated and found to range between  $5.77 \times 10^{-8}$  and  $7.26 \times 10^{-8}$ . Results obtained showed that the rate of photostabilization of PVC in the presence of the additive follows the trend:



According to the experimental results obtained, several mechanisms were suggested depending on the structure of the additive. Among them HCl scavenging, UV absorption, peroxide decomposer and radical scavenger for photostabilizer additive mechanisms were suggested.

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Peer review under responsibility of King Saud University.

<http://dx.doi.org/10.1016/j.arabjc.2012.03.004>



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## 1. Introduction

Poly(vinyl chloride) is second only to polyethylene among the five kinds of general plastic materials, which was widely used in industries including architecture, electronic, chemical engineering, packaging, transportation, etc. (Andrady et al., 1998). However, low photostability of PVC leads to hydrogen chloride loss, discoloration, and finally serious corrosion phenomena, accompanied by changes of physical and chemical properties of PVC.

Poly(vinyl chloride), better known by its abbreviation PVC, is one of the most versatile plastics. It is the second largest manufactured resin by volume worldwide (Saeki and Emura, 2002); currently, its production per annum exceeds 31 million tons. Braun (2004) described the most remarkable milestones in PVC history, their importance to the development of macromolecular chemistry, and some PVC research and industrial applications, with respect to polymerization, stabilization, bulk property modification, and chemical and material recycling of PVC waste.

The low cost and the good performance of poly(vinyl chloride) products have increased the utilization of this polymer in building, mainly in exterior application, such as window profiles, cladding structure and siding (Andrady et al., 1998). However, ultimate user acceptance of the PVC products for outdoor building applications will depend on their ability to resist photodegradation over long periods of sunlight exposure (Yousif et al., 2012a).

To ensure weathering ability, the PVC resin needs to be compounded and processed properly, using suitable additives, leading to a complex material whose behavior and properties are quite different from the PVC resin by itself (Gardette et al., 1993). On the other hand, it is important to perform reliable accelerated weathering test methods. In this regard, factors that influence the degradation of PVC based materials in the service condition, like light and temperature are accelerated.

Almost all synthetic polymers require stabilization against the adverse effect. With the development of synthetic resins it became necessary to look for ways and means to prevent, or at least reduce, the damage caused by environmental parameters such as light, air and heat. This can be achieved through addition of special chemicals, light stabilizers or UV stabilizers, that have to be adjusted to the nature of the resin and the specific application considered. The photostabilization of polymers may be achieved in many ways. The following stabilizing systems have been developed, which depend on the action of stabilizer: (a) light screeners, (b) UV absorbers, (c) excited state quenchers, (d) peroxide decomposers and (e) free radical scavengers, of these it is generally believed that types (c–e) are the most effective. Most of the stabilizers are believed to be multifunctional in their mode of operation. This view is complicated by the fact that mechanisms involved in photo-oxidation in turn depend on the polymer structure and other variables, such as manufacturing, operation, processing and conditions (Harper et al., 1974).

As part of our on-going research in the photostabilization of poly(vinyl chloride), the photostabilization of PVC was studied using diorganotin(IV) complexes with benzamidoleucine as a ligand.

## 2. Experimental

### 2.1. Materials

The following complexes were all prepared by the method described previously. (Farina et al., 2009; Yousif, 2012b).

### 2.2. Synthesis of benzamidoleucine

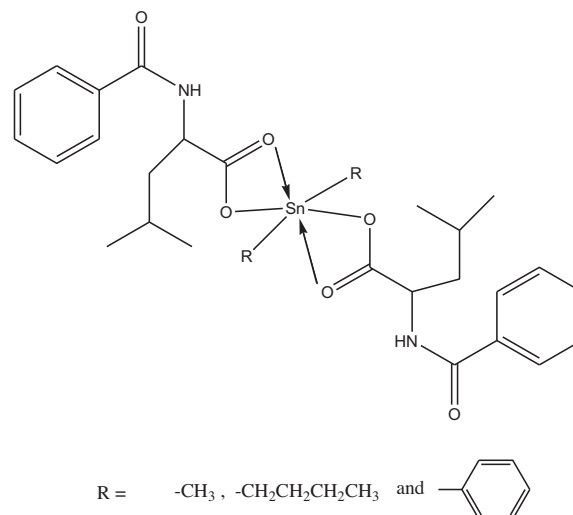
One gram of leucine was dissolved in 25 ml of 5% NaOH solution in a conical flask. To this mixture benzoyl chloride

(2.25 mL) was added in five portions in (0.49 ml increments) and shaken vigorously until all the chloride has reacted. Acidified with diluted hydrochloric acid the crude product was washed with cold ether. Finally, the desired product was recrystallized from ethanol.

### 2.3. Preparation of complexes

Complexes were synthesized by dissolving the free ligand (2 mmol) in hot toluene and adding the diorganotin salts (1 mmol) to the solution. The solution was refluxed for 6 h with magnetic stirrer and then cooled and filtered. The filtrate was reduced under vacuum to a small volume and solid was precipitated by addition of petroleum ether then filtered, dried at 60 °C and recrystallized from ethanol.

Ph <sub>2</sub> SnL <sub>2</sub>	C1
Bu <sub>2</sub> SnL <sub>2</sub>	C2
Me <sub>2</sub> SnL <sub>2</sub>	C3



## 3. Experimental techniques

### 3.1. Film preparation

Commercial poly(vinyl chloride) supplied by Petkim company (Turkey) was re-precipitated from THF solution by alcohol several times and finally dried under vacuum at room temperature for 24 h. Fixed concentrations of poly(vinyl chloride) solution (5 g/100 ml) in tetrahydrofuran were used to prepare polymer films with 30 μm thickness (measured by a micrometer type 2610 A, Germany). The prepared complexes (0.5% concentrations) were added to the films starting at 0 concentrations (blank). The films were prepared by evaporation technique at room temperature for 24 h. To remove the possible residual tetrahydrofuran solvent, film samples were further dried at room temperature for three hours under reduced pressure. The films were fixed on stands especially used for irradiation. The stand is provided with an aluminum plate (0.6 mm in thickness) supplied by Q-panel company.

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