

Mechanical Study of Some Polystyrene composites modified with adding inorganic fillers

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Abstract

Polystyrene-Zinc oxide microcomposites have been prepared for Mechanical study. The Zinc oxide micro particles were added to polystyrene by different concentrations that are (3, 5, and 7) by weight percent of the pure polymeric matrix. Solution casting method is used for preparing such composites. Different Mechanical properties of (PS-ZnO) microcomposites have been measured. Stress strain Curve is investigated for both pure Polystyrene and its composites with zinc oxide.

The results showed that the Tensile Strength varies with the increase of ZnO in a specific way. Elongation at break of (PS-ZnO) micro composites increase with increase the content of (ZnO). An explanation of such behavior in tensile strength as well as Elongation at break has been discussed.

Key Words : Polystyrene Composites; Tensile Strength; Elongation at Break

1. Introduction

Usually in the field of polymeric materials and their composites preparation, whether on micro-scale or nano-scale composites, Different types of micro- filler -reinforcement in combination with the bare polymer can greatly find a wide range of applications. The most common and versatile areas of applications are especially in the field of technology and engineering sector, this is due to their attractive and unique properties, such as enhanced thermal stability, electrical and magnetic properties and finally for sure mechanical strength as a major property for these composites [1–3].

Polymer micro composites have been studied extensively for many years and it has been shown that most of the physical and mechanical properties enhanced already by the addition of a specific concentration of inorganic micro fillers due to the unique properties of such additives.

Polystyrene (PS) is considered to be termed as the most durable thermoplastic polymer. It is widely used in big scale of different products due to its versatile properties. Polystyrene is characterized by the resistance to biodegradation, stiffness or flexibility (with plasticizers), light weight, good chemical and high insulation properties and easy to be synthesized.

It is utilized in many application such as latex paints, coating, synthetic rubbers and food-contact packing polymers, even in the field of electronics and building materials, and also as a material for the formation of bottles and dummy [4–6].

On the contrary, styrene easily copolymerizes with different monomers such as acrylonitrile, methacrylamide, butadiene and vinyl chloride, or others leading to create polymeric materials with unique properties suitable for many and large scale industrial applications [7–17].

Zinc oxide is a very important and interesting inorganic material and possess many and versatile characteristics, that for example cheap, abundant, easy to process and in the field of chemistry, it is called an Eco-friendly catalytic agent. Addition of Zinc oxide into the polymer makes an enhancement in disparate properties of the prepared composites and result in wide range of applications [18-19].

2. Experimental Work

2.1 Materials

Polystyrene (PS) was obtained from Aldrich Chem. Company, Hamburg, Germany, with weight and number average molecular weights of $M_w = 230,000$ g/mol and $M_n = 140,000$ g/mol, respectively.

Zinc oxide is a white powder (ZnO) that is in micrometer size used in this study. The host matrix is Polystyrene (PS). Different ratios of (ZnO) were prepared by weight percentage of pure polymer. Extra Pure Zinc Oxide was purchased from Alpha chemika (India).

2.2 Samples preparation

Simple solution casting method is used to prepare the composites of Polystyrene (PS) filled with Different contents of zinc oxide powder. These ratios are (3%, 5% and 7%) beside Pure Polymer sample.

2.3 Uniaxial Tensile Testing.

Mechanical Tensile test were performed according to standard test method **ASTM D 412** –“Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers – Tension”. Both Stress strain Curves as well as tensile strength and elongation at break were interpreted with the different contents of ZnO within PS matrix. These concentrations are (3%,5% and 7%) weight percent.

3. Results and Discussion

Stress Strain behavior of (Polystyrene – ZnO) micro composites with different content of (ZnO) i.e (3% - 5% - 7%) have been investigated. Figure (1) shows a typical Stress – Strain Curves for All samples including Pure Polystyrene.

From Figure (1), we can observe that as the concentration of (ZnO) begin to increase (3%), there is a small increment in the Elastic behavior than that pure Polystyrene. But as the content of Zinc Oxide increases more (5%), an apparent decrease is occurred. Finally, when the filler content becomes (7%), the mechanical behavior decrease again. This effect can be explained as follows.

The addition of zinc oxide into the polymeric matrix of Polystyrene led to a limited enhancement in mechanical behavior in comparison to pure Polystyrene, and as the content is raised within the polymeric matrix, we observe a decrees in the elastic modulus as we see in the stress – strain curve. The interfacial interactions between the filler and matrix play an important role in the overall mechanical performance of the composite systems. So there was not an appropriate distribution for particles of zinc oxide inside polystyrene [20].

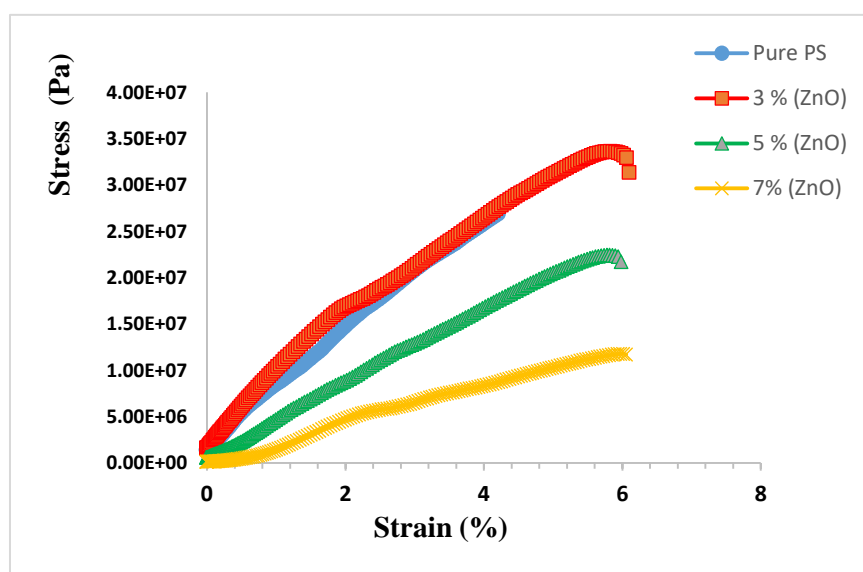


Figure 1. Stress Strain Curve of (Polystyrene – ZnO) microcomposites

On the other hand, Tensile Strength as a function of zinc oxide content is shown in Figure (2). At the beginning, we can see that with increasing the percentage of zinc oxide within polystyrene matrix, the Tensile Strength increase in a sample with (3%) filler loading. The pure polymer has tensile strength of nearly 20Mpa and the sample with (3%) ZnO has a value of 36.9 Mpa. As the content of ZnO increase, there is a lowering in the values of tensile strength.

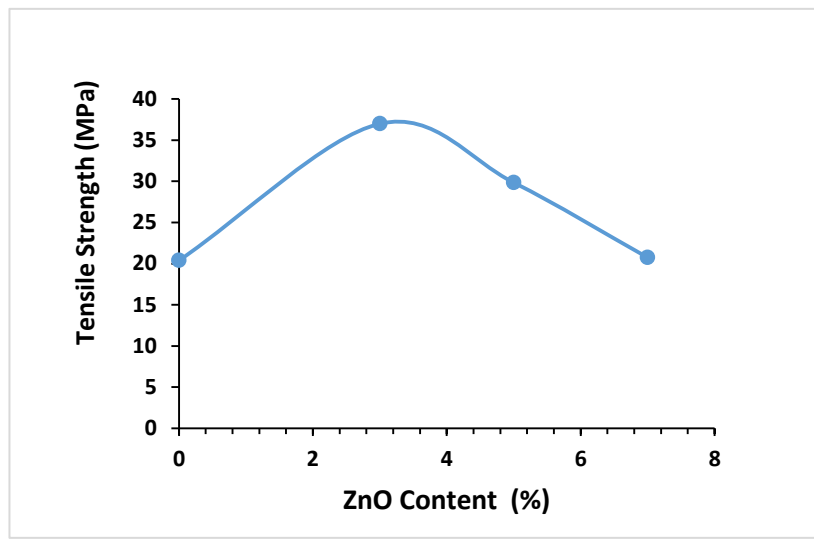


Figure 2. Tensile Strength of Polystyrene samples as a function of zinc oxide content.

Elongation at break and its change with respect to zinc oxide concentration is shown in Table (1).

Table 1. Elongation at break as a function of Zinc Oxide

(ZnO) Content	Elongation at break (%)
0 %	4.20
3%	5.82
5%	5.82
7%	5.97

We can observe that, Elongation at break in nearly increase with incasing ZnO content which is comparable to the behavior of stress strain response of the tested samples.

Only in scarce situations, if there is a good adhesion between the polymer and the filler, the fracture goes from particle to particle rather than following a direct path, and thus the filled polymers have higher elongations at break compared to the neat polymer [21].

4. Conclusion

Polystyrene micro composites containing ZnO were synthesized and characterized. These particles can be incorporated into polystyrene in different weight ratios (3% ,5% and 7%). Mechanical properties showed significant improvement with low loading of micro filler (3%) in atypical stress strain curve. The pure polymer has a tensile strength of nearly 20Mpa and the sample with (3%) ZnO has a higher value of 36.9 Mpa. Elongation at break has increased with incasing ZnO content.

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