

## The Study of the Effect of Nano -Materials on the Mechanical Properties of Polymer Matrix Composite Materials

Ibrahim A. Atiyah

Material Engineering Dept. || Faculty of Engineering || Al- Mustansiriyah University || Baghdad || Iraq

**Abstract:** In a lot of industrial applications the Composite materials have an essential role. The manufacturing of the new composite materials is intended improve the materials applicability. In this work, the influence of silica Nano filler type-and compared that effect with that of silica micro fillers-on mechanical properties of polyester have been investigated. For this purpose, mechanical testing have been used. The addition of Nano silica and micro silica was in different percentages 1%, 3%, and 5%, due to the fact that Polyester is one of matrix of polymer that is frequently used with strengthening fibers for sophisticated applications of composites because of its resistance to corrosion, cost that is low, smooth coping, and its ability to prevent the outbreak of flame.

**Keywords:** Nano -Materials, Mechanical properties, Polymer.

### Introduction

Nano composite increases the usability of biodegradable polymers. It is increasing the thermal stability of polymer [1]. Nano composites are defined as polymers that include Nano fillers. The Nano composites microstructure has inhomogeneous parts in Nano meters scare range. The range between polymers that are organic and the glasses that are inorganic is covered by Nano composite materials. To improve the polymers function, the polymers fillers have been used for a long time. It is demonstrated that Nano composites frequently favorable and unusual for the properties of the user properties. The report of the literature reflects the enhancement of the polymer Nano composites qualities in comparison with the polymers that are pristine. This ambiguous statement is meant to be an enhancement of the properties of the polymers in relation to the application of the polymers. The fabricated Nano composte are manufacturing smilare to the conventional polzmercompoite materials. Therefore, Nano compistes are attractive for manufacturing [2]. Nano fillers especially Nano fibers of carbon (CNFs), silica, organoclays, or Nano tubes, are frequently mixed with polymers that have been foamed and this is done for various reasons, such as increase in the nucleation, reduction in the size of the cell, or the improvement of property ref. of the barrier. It is often seen that the Nano fillers improve the foams mechanical qualities [3].

In this work the Nano silica and micro silica in different percentages (1%, 3%, and 5%) have been added to the polyester matrix with reinforcing fibers.

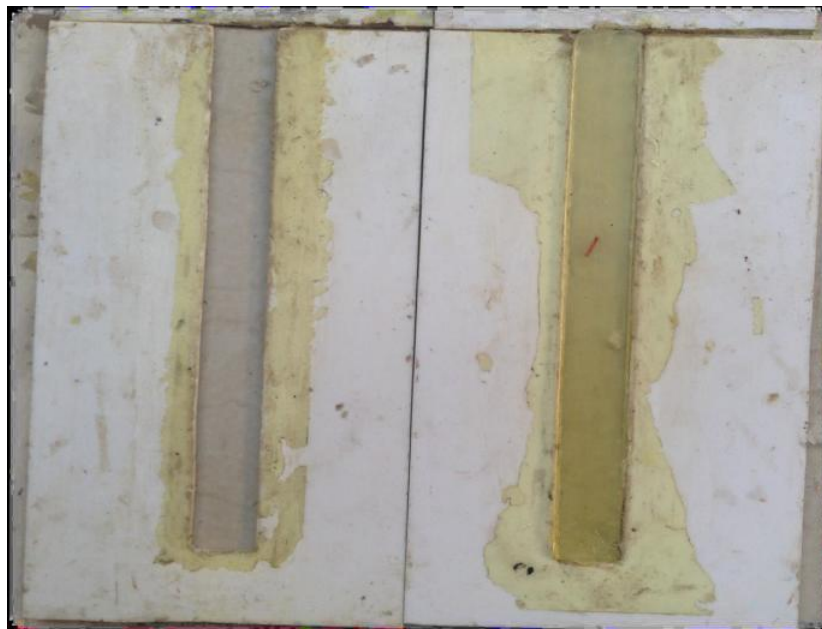
The review of the most research about the Nano particles loading on mechanical properties of silica-epoxy Nano composites was presented in Ref. [4].

The Nano composites properties extremely depend on the organic matrix, the content of Nano particles, their shape and size as well as on the way of the preparation of a Nano composite. Currently, many details are reported concerning the relationship between property and composition as well as the effects of adding different clays on the properties that are thermal— the properties of polyurethanes that rely on diols of polycarbonate with Mw that is about 1000. [5].

### **Experimental work**

#### **Mould Preparation**

The required moulds for preparing the test specimens were made from acrylic with dimensions of (250×25×2.5) mm as shown in Fig. 1. The internal walls was coated with thin layer of wax to avoid sticking between cast material and the mould wall.



**Fig. (1) Preparing the test specimens**

### Test specimen s Preparation

The steps of test specimen s preparation are explained as follows:

- a. The fillers particles was controlled by weight fraction (wt %) was with percentage 1%, 3% and 5% of the mixture weight. Then mixing them for two minutes in glass rod.
- b. By avoiding the formation of bubbles that result in the physical hard that is cast, the mixture was added into the mould from the corner and pouring that is the same in all cases and time continues until filling the mould to reach the needed level.
- c. To get rid of any remaining parts of bubbles, the mould was shaken by hand. The mixture may still have gases because of the evaporation. By doing so, the mould that is the same in all cases will be gained.
- d. For 24 hours the mixture has been kept in the mould under temperature of the room.
- e. All samples put in furnace 60 k for 3-4 hrs to get the final toughness. [18]

### Mechanical Test

To evaluate the materials and understand their durability and quality, tensile test is carried out. This test performed at room temperature by using universal tensile test according to ASTM-D 3039 [6]. The standard sample with dimension of (250×25×2.5) mm and 2.5 mm thickness, see Fig. 2 left. The test of hardness is carried out by resorting to the use of the hardness of the shore hardness (D) based on ASTM at room temperature, see Fig. 2 right.



Fig.(2) (left universal tensile test, right) shore hardness (D)

## Results and Discussion

This paper investigate the mechanical properties of Nano and micro silica on mechanical qualities of the Nano composites of the silica-polyester. The Nano composites of Silica-epoxy are one of the most familiar type of Nano composites, and that is why it is given special importance. [4]. The effect of the loading, size, and shape of the Nano particle on mechanical ways in which the Nano composites of silica-epoxy behave are studied by some of researchers [7][8][9][10][11][12][13] [17]. Liu et al have also studied the effects of the fraction of weight of Nano particles of silica on the epoxy behavior that is tensile [10]. He measured the yield stress as well as the young's modulus at various quantities of weight fractions. It has been demonstrated that the yield stress as well as the Young's modulus of Nano composite of epoxy or silica have risen gradually with rising of the fraction of the weight of particles of silica. There has been an increase in yield stress that is tensile and this is done mainly by phenols that are hindered instead of the particles of the silica [14]. By adding Nano silica, the mechanical and dynamic properties, the strength that is tensile, and the stability that is thermal of the Nano composites have been enhanced, see Fig. 3.

It was reported that they oung's modulus as well as the tensile stress of Nano composites rise by increasing the fraction of the weight of Nano fillers of the silica. In addition, the critical values of weight fraction that influencing the strength is 30%. However, some observations were reported in other Refs. [11] [15] [16]. The micro silica Nano particles showed little different effect on hardness of the Nano composite, see Fig. 4.

The values of tensile strength of micro and Nano silica at 30% weight fraction were found to be dropped. The improvement of strength for Nano silica was increasing with the weight fraction.

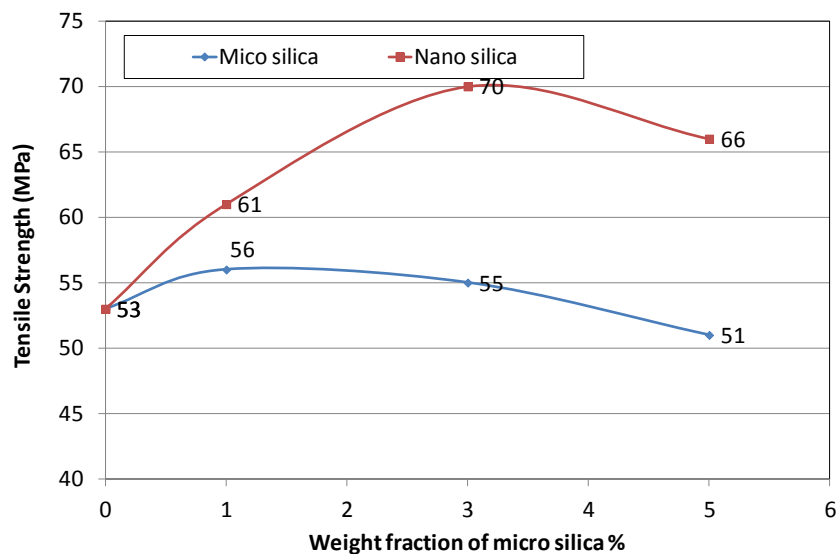


Fig. (3) Tensile strength and filler content of micro silica and Nano silica of polyester composite.

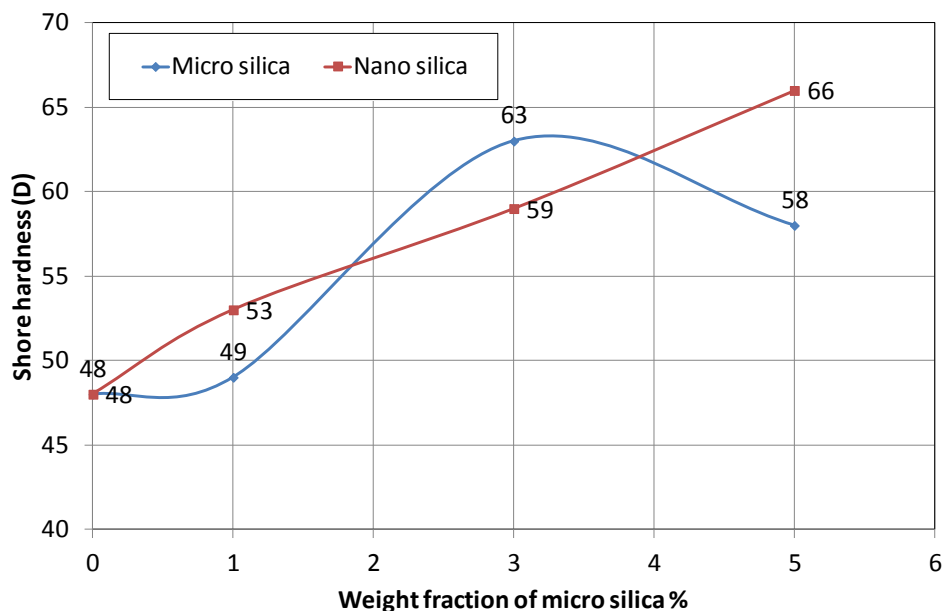


Fig. (4) Shore hardness and filler content of micro silica and Nano silica of polyester composite.

## Conclusions

Nano and micro silica enhance the hardness of the composite. In the case of micro silica a small drop in hardness value was observed after the critical values of weight fraction 30%. This could be explained by the decrease of adhesion strength between the polyester matrix and the micro silica which led to the decrease of the strength of the composite. This study examines a specific aspect of the ways in which the mechanical properties are affected by the Nano filler. Nano filler can give many other useful effects: the nucleation of the foaming bubbles, reduction in the size of the cell, functioning as barriers of diffusion, rising the electrical degrees of conductivity, making the foams more stable through the adsorption that is interfacial, making the foam more stable by having decreased crystallinity, enhancing the retardancy of fire, decreasing thermal degrees of conductivity, and rising the content of the cell.

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### دراسة تأثير المواد النانوية على الخواص الميكانيكية للمواد المركبة من مادة البوليمر المصفوفة

الملخص: في كثير من التطبيقات الصناعية، تلعب المواد المركبة دورًا أساسيًا يهدف تصنيع المواد المركبة الجديدة إلى تحسين قابلية تطبيق المواد في هذا العمل، حيث تم التحقيق في تأثير نوع السيليكا ومقارنة هذا التأثير مع الخواص الميكانيكية للبوليستر بإضافة السيليكا لهذا الغرض، تم استخدام الاختبارات الميكانيكية وذلك بإضافة باودر السيليكا بنسب مئوية مختلفة 1% و 3% و 5%، بسبب حقيقة أن البوليمر هو أحد مصفوفة البوليمر التي تستخدم بكثرة مع تقوية الألياف للتطبيقات المتطورة للمركبات بسبب مقاومتها للتآكل، والتكلفة المنخفضة، والتكيف السلس، وقدرته على منع اندلاع اللهب.

الكلمات المفتاحية: المواد النانوية، الخواص الميكانيكية، البوليمر.