ISSN: 0067-2904

The Bending Property of the Epoxy (Ep / Mgo)And (Ep/Sio$_2$) Composites After Immersion in Chemical Solution

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Abstract
In this paper, a polymer-based composite material was prepared by hand Lay-up method consisting of epoxy resin as a base material filled with by magnesium oxide powder once and silicon dioxide powder again and with different weight ratios (3%, 6%, 9%, 12%). The three-point bending test was performed in normal conditions and after immersion in sulfuric acid. The results showed that the bending value decreased with the increase of the weighted ratio of the filled nano powder (MgO, SiO_2) .The Bending of samples filled with by SiO_2 was found to be less than the bending of samples filled with by particles (MgO), the bending of the SiO_2 sample (0.32mm) at the weighted ratio (3%) and for the MgO (0.18mm) sample at the weight ratio were the same at the same weighted load (100 g). It was found that the bending values of all samples exceeded the value after immersion in sulfuric acid. The percentage of weight (6%) at the load level (500 g) was changed from 1.16mm in normal conditions to 1.48mm for the same weight ratio after immersion. In sulfuric acid diluted with 0.3N for 10 days at the same Applied load.

Keywords: Mechanical properties , polymer, Ep., Bending Property, H_2SO_4

خاصية الانحناء للإيبوكسي (Ep / MgO) و (Ep / SiO_2) المركبة بعد الغمر في المحلول الكيميائي

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الخلاصة
في هذا البحث تم تحضير مادة متراكبة ذات اساس بوليمري بطريقة القولبة اليدوية مكونة من راتنج الايبوكسي كمادة اساس مضاف اليه بمسحوق اوكسيد المغنيسيوم مرة ومسحوق ثاني اوكسيد السليكون مرة اخرى وبنسب وزنية مختلفة (3%,6%,9%,12%) . وتم اجراء اختبار الانحناء ثلاثي النقط في الظروف الطبيعية وبعد الغمر في حامض الكبريتيك. بينت النتائج ان قيمة الانحناء تقل مع زيادة النسب الوزنية للمادة المضافة (MgO,SiO_2). وجد ان الانحراف للعينات المضافة بدقائق (SiO_2) اقل من الانحراف للعينات المضافة بدقائق (MgO) فمثلا كان الانحراف لعينة SiO_2 (0.32mm) عند الكسر الوزني (3%) و لعينة MgO (0.18mm) عند الكسر الوزني ذاتة عند مقدار الحمل المسلط ذاته (100 g) . وتبين ان قيم الانحراف لجميع العينات قد زادت عن قيمتها بعد الغمر في حامض الكبريتيك و تغيرت عند النسبة المئوية الوزنية (6%) عند مقدار الحمل (500 g) من (1.16mm) في الظروف الطبيعية واصبحت (1.48mm)

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للنسبة الوزنية ذاتها بعد الغمر بحامض الكبريتيك المخفف بعيارية 0.3N لمدة 10 ايام عند مقدار الحمل المسلط ذاته .

Introduction

Polymer composite materials are of the best materials because they are characterized by high mechanical properties as well as easy to manufacture. It is one of the most modern materials used in most technological and engineering applications. The most important requirements for use of these materials are good durability, high performance, resistance to internal and external stresses, as well as resistance to the surrounding conditions of temperature, pressure, etc [1].

The researchers were interested in studying polymeric complexes supported by Particles of MgO in particular for the characteristic of resistance to oxidation and bear to high temperatures and characterized by the fragility but it has the strength of compression and hardness and chemical inactivity [2]. In 2013, the researcher Shayma prepared the unsaturated polysaccharide resin reinforced by silicon dioxide and studied the mechanical and electrical properties at different weight ratios The results showed that the tensile strength and bending strength of the base material was higher than the composite material. The elasticity coefficient of the composite material was higher than the base material and showed that the hardness of the composite material was much higher than the hardness of the base material This improvement in properties increases with the increase of the silica weight fracture [3]

In 2014, the researcher, Rafqa, studied an composites polymer-based material. Epoxy resins were used as a base material and magnesium oxide powder (MgO) as a strengthening agent at different fractures and had a hardness test and bending test. The results showed that the value of the hardness increased by a nonlinear relationship with the increase of the weight fracture of the Particles well as the values of the bending coefficient of elasticity increased with the increase of the weight fracture [4].

In 2015, Salma et al. Studied the magnesium oxide-supported epoxy complexes and studied the effect of acid adsorption on some physical properties using sulfuric acid and 1M concentration for up to 10 weeks. The results of the hardness test before and after immersion showed that it increased with the increase of the weight fracture The magnesium oxide and its pre-immersion value are higher than the value after immersion. The results of the insulation strength were found to decrease with the increase of the weight fractions of the material of the reinforcement and increase the immersion time[5]. In the (2016), the researcher Fuaad, prepared polymer complexes of unsaturated polystyrene resin supported by micro-magnesium and nano-oxide. In the following weights (3%, 6%, 9%, 12%, 15%). The results showed that the value of hardness increased with increasing concentration of (MgO) in the compound for all cases(Adding nano-magnesium oxide to the resin once and the magnesium oxide once again and mixing them again) The bending results showed that the deviation was directly proportional to the load applied to all samples and the bending coefficient was reduced by increasing the concentration of MgO for all samples [6].

Bending test

Bending test is one of the most complex and important basic tests of complex materials to determine the properties of elasticity, elasticity, and bending resistance of a material that expresses its ability to withstand vertical forces on its longitudinal axis without breaking Where the sample is subjected to two types of stress compressive stress on the top surface of the sample and tensile stress on the surface of the bottom of the sample and sometimes overcome each other and thus cause the failure of the material as a whole There are a number of important factors that affect this test is the rate and type of loading and distance between the predators and the dimensions of the cross section [7].

We calculated the bending strength in the three-point test method, which is one of the most common and easy tests shown in Figure-1. The elasticity factor E measured in N / mm^2 (or Mpa) can be calculated by the following relationship [8]:

$$E = \left(\frac{Mass}{Deflection}\right)\frac{g\,L^3}{48\,I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: $\left(\frac{\text{Mass}}{\text{Deflection}}\right)$

It represents the slope of the straight line calculated from the Mass-Deflection curve. g: ground acceleration (9.81 m / sec^2), L: length of sample between assignors (m)

I: represents the determination of the geometrical curve (m^4) given by the following equation [8]:

$$I = \frac{b\,d^3}{12} \quad \text{.....(2)}$$

Where: b: sample width (m), d: sample thickness (m)

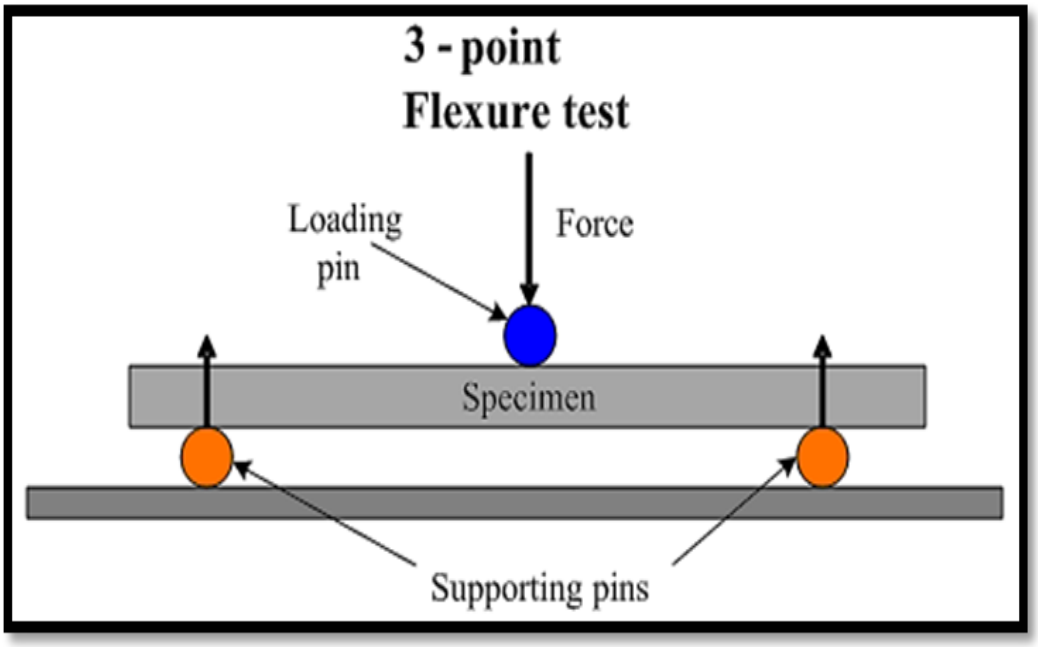


Figure 1-Three-point bending test [6].

practical part

The practical part includes the following:

First: Materials used in research

The following materials were used in this research:

1- Epoxy resins: which is a transparent liquid form type (Epoxy Sikadur ® 52 LP) And manufactured by the US company (Sky Spring) of the United States , which solidifies after addition of the hardener of its type (Bisphenol A (epichlorohydrin) Oxiraine) The plant is made by the US company Sky Spring and has a hardened ratio to resin. (2: 1)

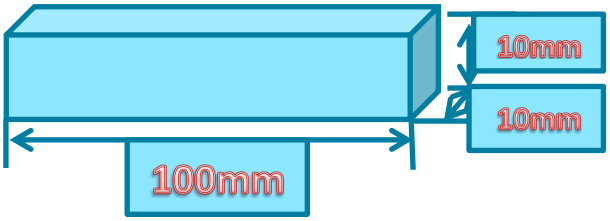
2- Magnesium oxide powder (MgO)): Use the magnesium oxide powder imported by the US company (Sky Spring) and grain size 50 µm , density (3.358 g / cm) and purity (99%).

3- Silicon dioxide (SiO_2) : - Silicon dioxide imported from the US company (Sky Spring) was used in grain size 100 µm , density (2.6 g / cm^3) and purity 99%.

Second: Preparation of bending test models:

Hand Lay-up method was adopted in the process of preparation of samples and this method was used without the other complex contingencies for its ease, being convenient and low cost. A glass panel with a glass casting mold has been adopted with special treatments for the purpose of non-adhesion of the models with the casting board. Mix for 8-10 minutes. And then pour into the template Supplied and then leave the templates for 48 hours for the purpose of completion of the process of hardness. The samples are then placed in the electric oven as shown in Fig. 1 for 3 hours at 50 °C .The samples are then left for 15 days to complete the polymerization process before the samples are examined. . After the previous operations, the Composite materials models are obtained with a thickness of (3mm) The cutting and smoothing process is then carried out according to the standard specifications using a soft tooth strip saw. The samples are cleaned with zero-floured leaves and the photographs are shown in Figure-2 and Table-1 shows the global measurement of the bending samples.

Table 1-Global measurement of bending samples.

ASTM-D790-86		Bending Test Sample

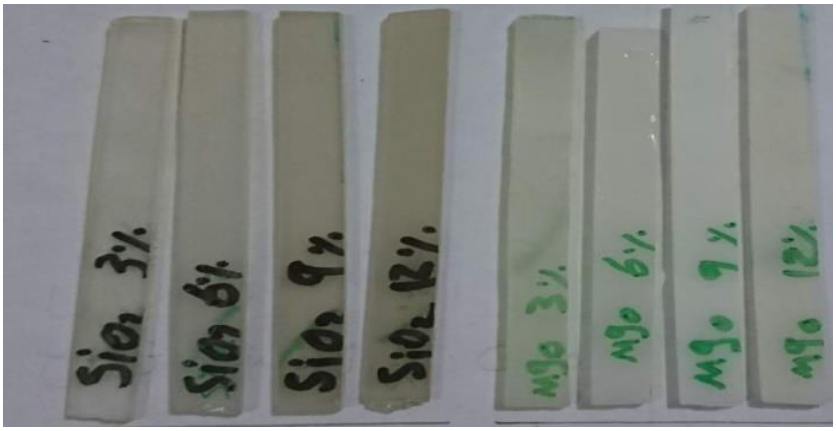


Figure 2-Photograph of the bending sample.

Three Point Bending Test

The three-point bending test, a currency principle, involves the installation of the sample from both ends on two centers. The force is placed on the sample by gradually suspending the blocks on the stand at the center of the sample and at (5mm/min) . Causing gradual bending. By measuring the deviation index, it is possible to read the deviation of each sample, with known standard dimensions mm^3 (100×10× 4) . as shown in Figure-3.

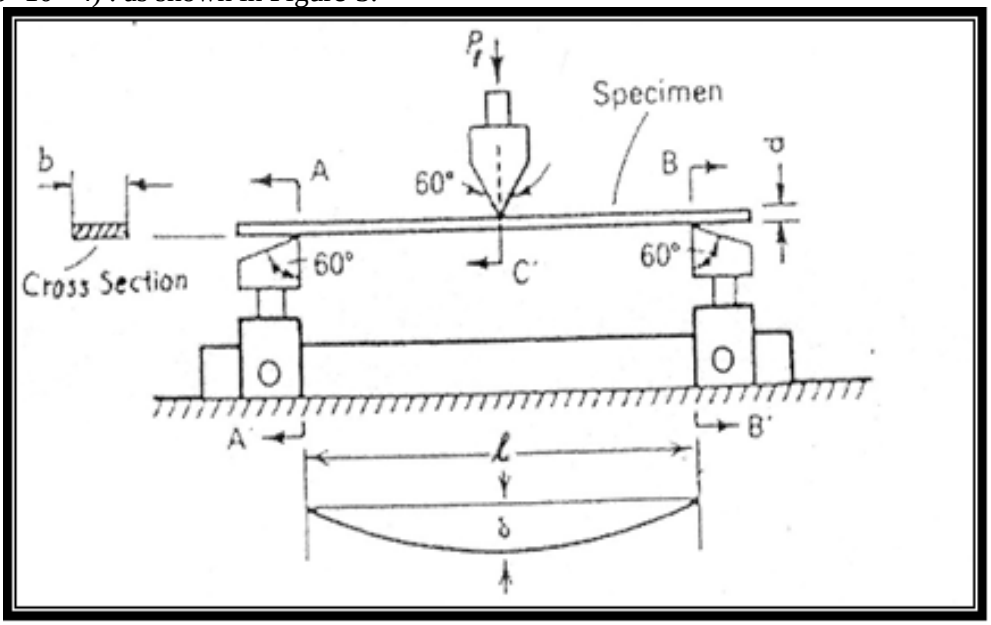


Figure 3- Three Point Bending Test.

Results and discussion

From Tables-(2,3) and Figures-(4,5), we notice that the Bending of MgO and SiO_2 samples increases with the increase in the load as the material returns its normal condition. Where the material retrieves its original state after the elimination of the load exerted on it as the overlapping material will

suffer the tension and elongation of polymer chains Without breaking the bonds as they fall within the elastic zone deformation.This indicates that the material is subject to the Hook's law and after calculating the ratio between the mass and the deflection which represent the slope can calculate the Young's modulus [8,9].

From the above tables and figures, the value of the bending is inversely proportional to the weight ratios for reinforced material . The SiO_2 deflection was less than the deflection of MgO samples at the same weight ratios.The bending value At the concentration of 6% (0.27mm) and became (0.18mm) at the concentration of 12% at the same load (100g)[10, 11] . While the bending value of SiO_2 samples at 6% concentration was (0.18mm)and became (0.11mm) at 12% at the same load (100g) [12,13]. and The reason for the lower bending value of SiO_2 samples than for the rest of the samples is due to the high correlation between the components of the complex material and the silica of the high-strength glass materials and Because of the increase in the particle of the additives, it will reduce the amount of deflection and thus reduce the fragility of the complex material due to the density of the bonding and thus restricting its movement so that which increases the coefficient of elasticity. In addition, magnesium oxide-reinforced samples are less common at the same weight ratios for the rest of the samples.Leading to increased interstitial distances and reduced stacking and bonding and increased sliding of polymer chains to the base material and thus increased deflection [14,15].

The shapes (6 and 7) show the mass relationship with the deflection after immersion with sulfuric acid diluted for 10 days for MgO and SiO_2 samples .We observe that the deflection values of all samples have exceeded their value in normal condition because of the negative role of the acid solution When reinforcing material substances are exposed to the chemical solutions that are spread in the base material, where the bonds are separated from one another, the material becomes more flexible, thus reducing its elasticity factor [16,17]. The deflection value of the MgO micrograph was 9% before immersion (1.39 mm) at the load applied (300 g) and became (1.77mm) for the same weight after immersion with diluted sulfuric acid at the same weighted load [18].

After calculating the slope of the samples of forms (4, 5, 6 and 7) before and after immersion with hydrochloric acid and then calculating the Young's modulus using equations (1) and (2) and The results shown in Tables (4) show a change in the Young's modulus with the weight percentage of the magnesium oxide samples and the silicon dioxide samples and forms (8 and 9) Note that the value of the Young's modulus of the reinforcing samples by SiO_2 and MgO particles increases by increasing the weight percentage [19,20].

For example, the value of the Young's modulus was for MgO samples at 3% concentration (1.38GPa) and became (2.61GPa) at the concentration of 12%. For SiO_2 samples it was (1.74GPa)at the weight ratio(3%) and (2.89) at the weight ratio(12%). Note that the highest values for the Young's modulus were for SiO_2 particles and MgO particles. For example, at the weight ratio (6%),the Young's modulus of MgO (1.67GPa) and SiO_2 (2.01GPa) The reason for possession of the samples reinforced by the second silicon oxide is the highest values for the Young's modulus when compared with MgO samples. This is due to the fact that the powder of SiO2 particles of glass material with high fragility. And their homogeneous distribution within the base material will reduce the amount of deviation and thus increase the Young's modulus [21,22]. Figures-(10, 11) shows that the value of the Young's modulus decreases with increasing immersion time And increase the proportion of the material of reinforcing For example, the value of the Young's modulus for MgO samples at 1.19GPa concentration was 3% and became 1.76GPa at concentration 12% [23] .

Figures- (12, 13) shows the comparison of the Young's modulus value for all samples before and after immersion. Note that the value of the Young's modulus after immersion with sulfuric acid for the samples of all aggregates has been compared to its value in normal conditions (before immersion) the value of the for the Young's modulus sample supported by particles of MgO (2.16GPa) at the weight ratio (12%) before immersion and became (1.76GPa) after immersion at the same weight ratio, while the value of the Young's modulus for the sample reinforced by SiO_2 particles was (2.89GPa) at the weight ratio (12%) And became (2.64GPa) at the same rate of weight and the reason for this is because the chemical solution of acid has caused the erosion and breakage of interlocking bonds and reduce this value by increasing the period of immersion [24,25].

Conclusion

1. The value of the deflection is directly proportional to the applied load and vice versa with the weighted percentages of SiO_2, MgO and the deviation is increased by increasing the immersion time in the diluted sulfuric acid by 0.3N and for 10 days.
2. The increase in the concentration of MgO, SiO_2 and the total sample groups in the SiO_2 samples is greater than in the MgO samples. After the samples were immersed with 0.3N the diluted sulfuric acid, The Young's modulus value of the samples is lower than that of the samples Natural.

Table 2-Mass relationship with deviation of MgO samples in normal conditions and after immersion in H_2SO_4 acid for 10 days.

Mass (g)	Deflection (mm)							
	Wt MgO 3%		6%		9%		12%	
	N.C	A.I.T(d)	N.C	A.I.T(d)	N.C	A.I.T(d)	N.C	A.I.T(d)
100	0.32	0.4	0.27	0.35	0.23	0.28	0.18	0.21
200	0.59	0.75	0.5	0.66	0.42	0.56	0.35	0.44
300	0.85	1.08	0.73	0.94	0.62	0.81	0.52	0.68
400	1.1	1.37	0.95	1.22	0.83	1.08	0.71	0.91
500	1.33	1.69	1.16	1.48	1.02	1.31	0.89	1.13
600	1.55	1.97	1.37	1.75	1.21	1.53	1.08	1.37
700	1.77	2.22	1.56	1.99	1.39	1.77	1.27	1.59
800	1.98	2.48	1.77	2.27	1.58	2.01	1.46	1.82
900	2.21	2.75	1.99	2.51	1.79	2.24	1.63	2.03
1000	2.45	2.98	2.21	2.73	1.98	2.48	1.83	2.25

Table 3-Mass relationship with deflection of SiO_2 samples before and after Immertion with diluted sulfuric acid for 10 days.

Mass (g)	Deflection (mm)							
	Wt SiO2 3%		6%		9%		12%	
	N.C	Immertion	N.C	Immertion	N.C	Immertion	N.C	Immertion
100	0.23	0.29	0.18	0.22	0.14	0.18	0.11	0.13
200	0.45	0.54	0.36	0.43	0.3	0.35	0.23	0.28
300	0.67	0.77	0.55	0.62	0.45	0.5	0.37	0.41
400	0.88	0.98	0.74	0.81	0.62	0.66	0.51	0.57
500	1.11	1.19	0.93	0.99	0.78	0.83	0.65	0.71
600	1.32	1.41	1.12	1.18	0.95	0.99	0.79	0.87
700	1.53	1.61	1.31	1.37	1.12	1.16	0.94	1.03
800	1.74	1.82	1.51	1.57	1.29	1.35	1.1	1.19
900	1.97	2.03	1.72	1.78	1.48	1.54	1.25	1.36
1000	2.19	2.22	1.93	1.98	1.66	1.74	1.41	1.54

Table 4-The relationship between the Young's modulus and the weighted fracture of MgO and SiO_2 samples in normal conditions and after immersion in H_2SO_4 and for 10 days.

Group No.	Sample Weight Fraction (%)	Young's Modulus (GPa)	
		N.C	Immertion 10day in H_2SO_4 Solution
G.1 SiO_2 EP+ Particles	**3**	1.74	1.52
	6	2.01	1.77
	9	2.47	2.18
	12	2.89	2.64
G.2 MgO EP + Particles	**3**	1.38	1.19
	6	1.67	1.33
	9	1.91	1.58
	12	2.16	1.76

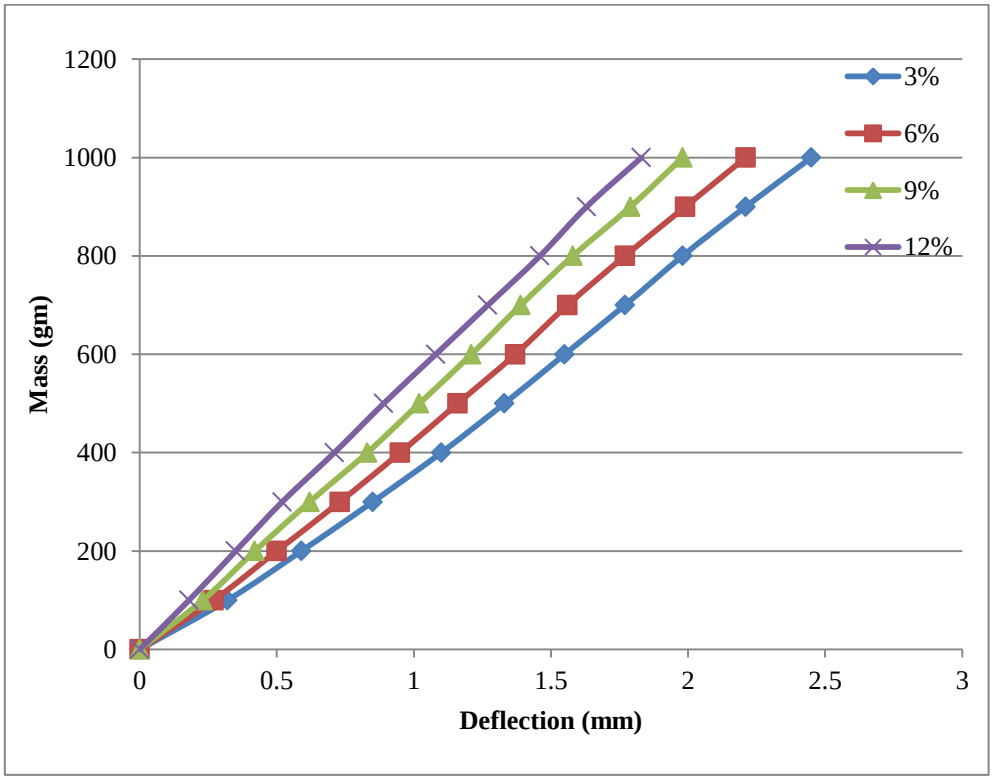


Figure 4-Mass relationship with deviation of MgO samples in normal conditions**.**

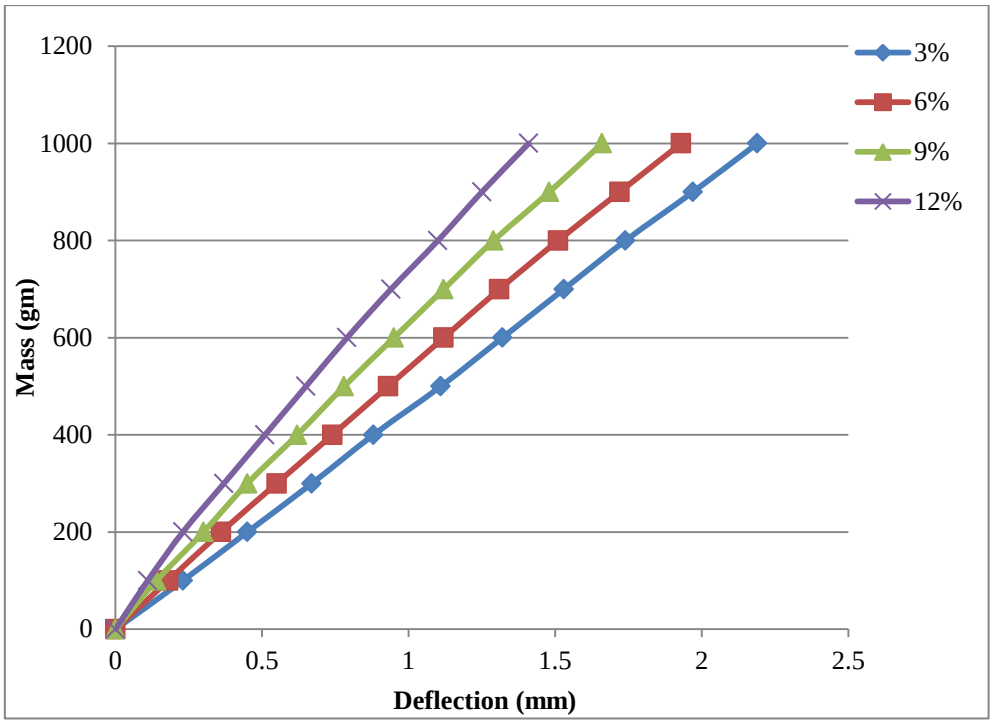


Figure 5-Mass relationship with deflection of SiO_2 samples in normal conditions.

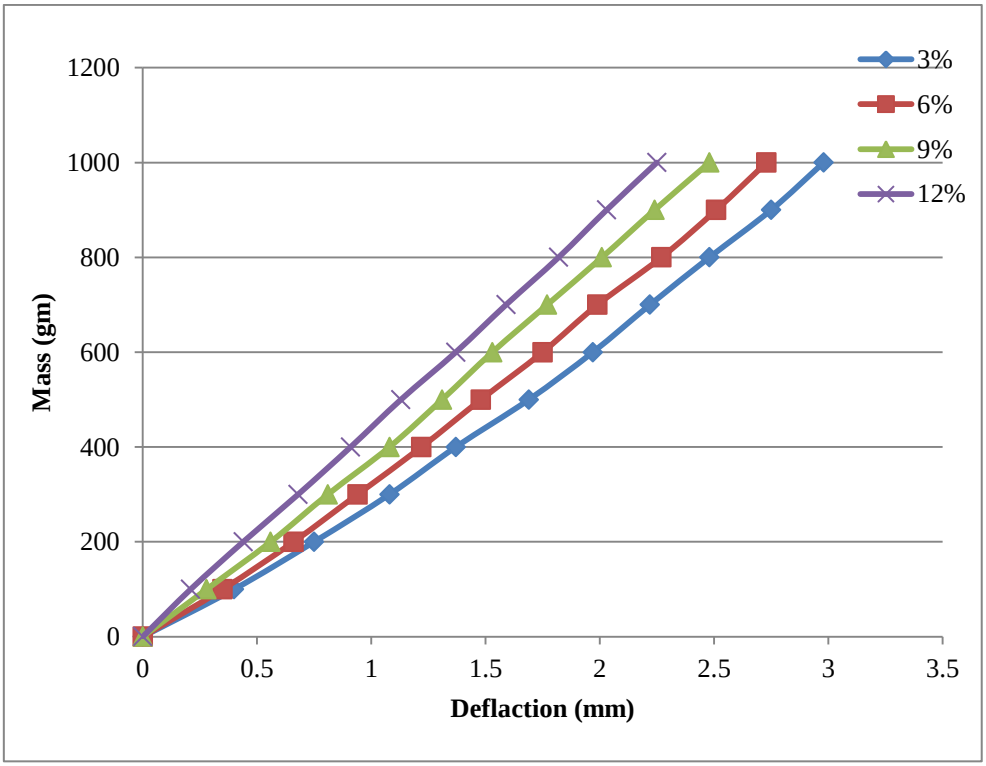


Figure 6-shows the mass relationship with the deviation of MgO samples after immersion in diluted sulfuric acid for 10 days.

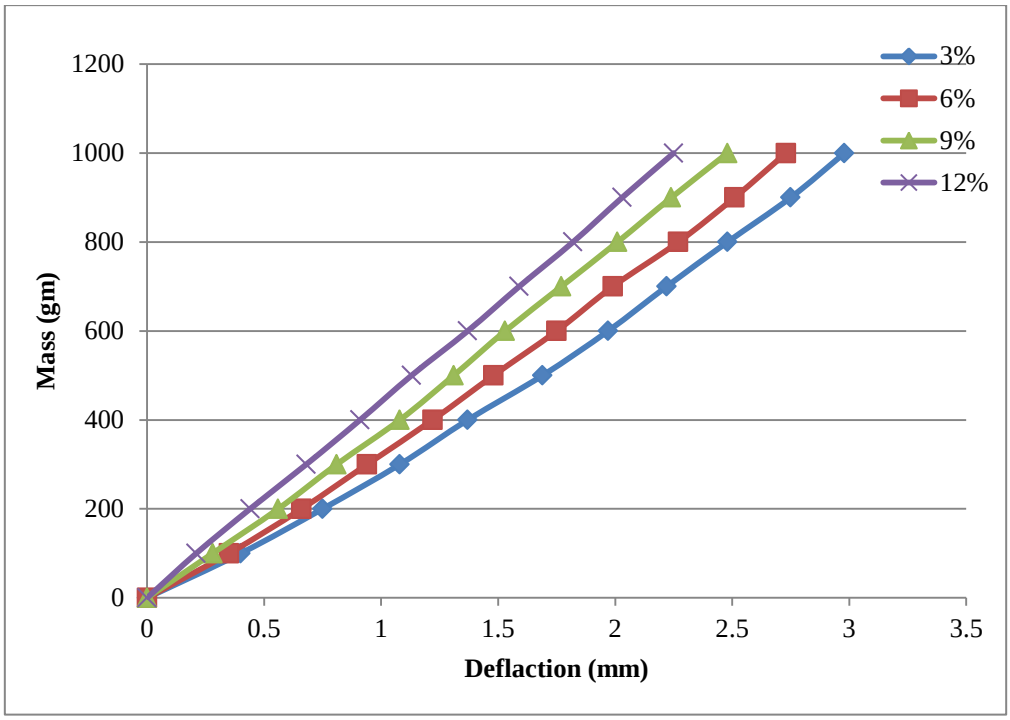


Figure 7-shows the mass relationship with the deviation of SiO_2 samples after immersion in diluted sulfuric acid for 10 days.

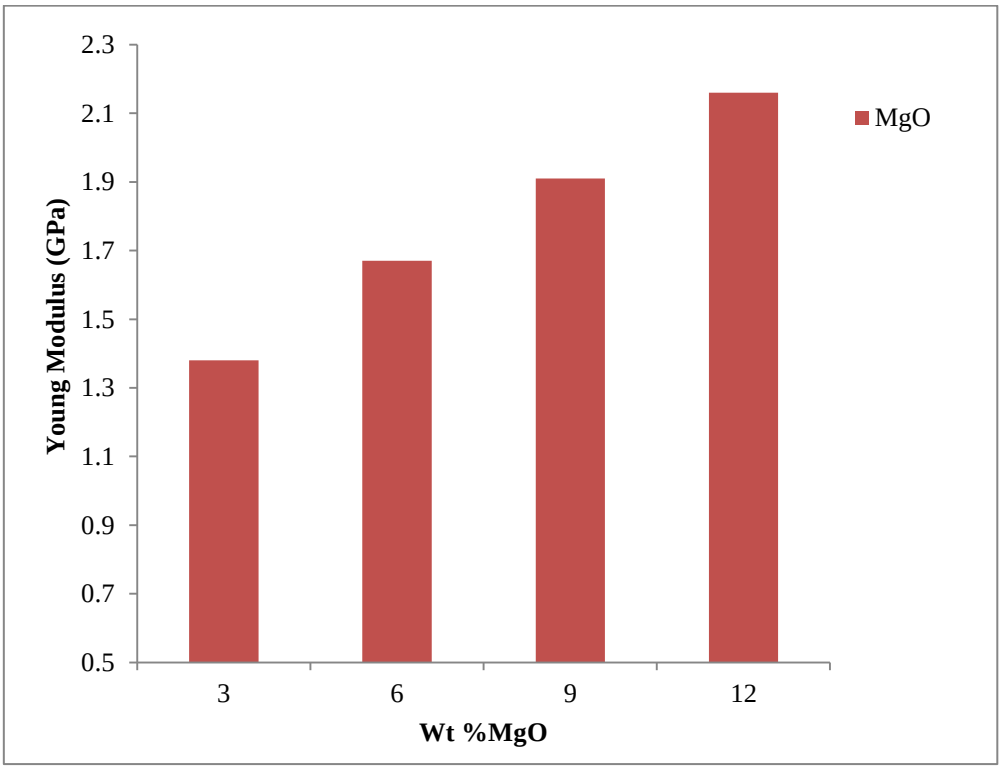


Figure 8- Young's modulus values with the weighted fraction of MgO samples in normal conditions.

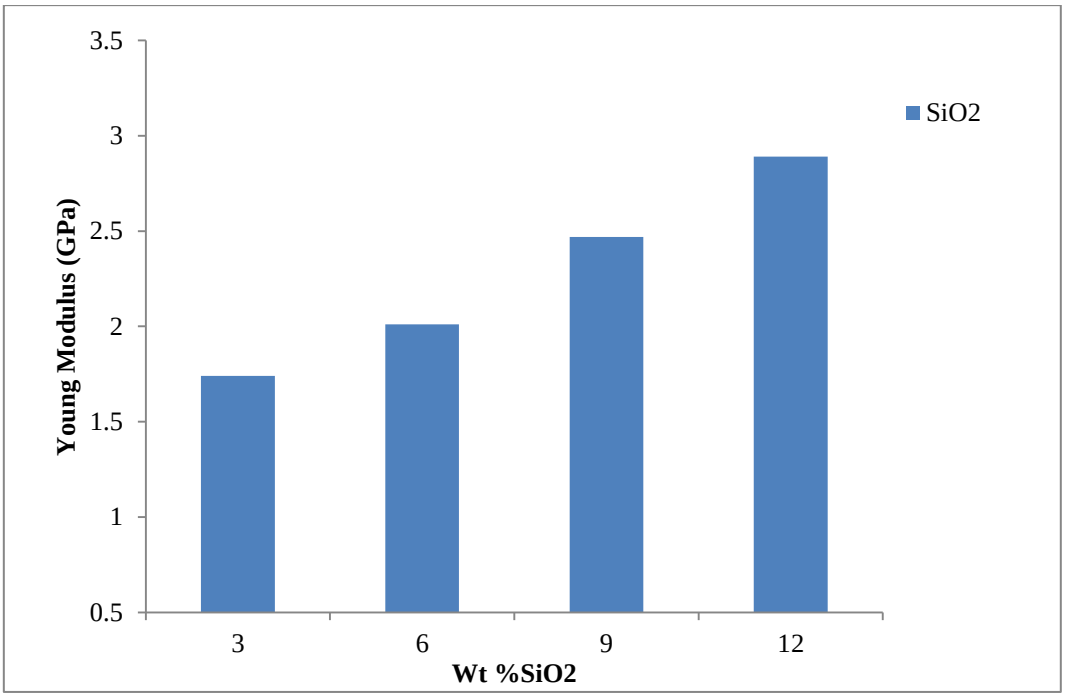


Figure 9-Young's modulus values with the weighted fraction of SiO_2 samples in normal conditions.

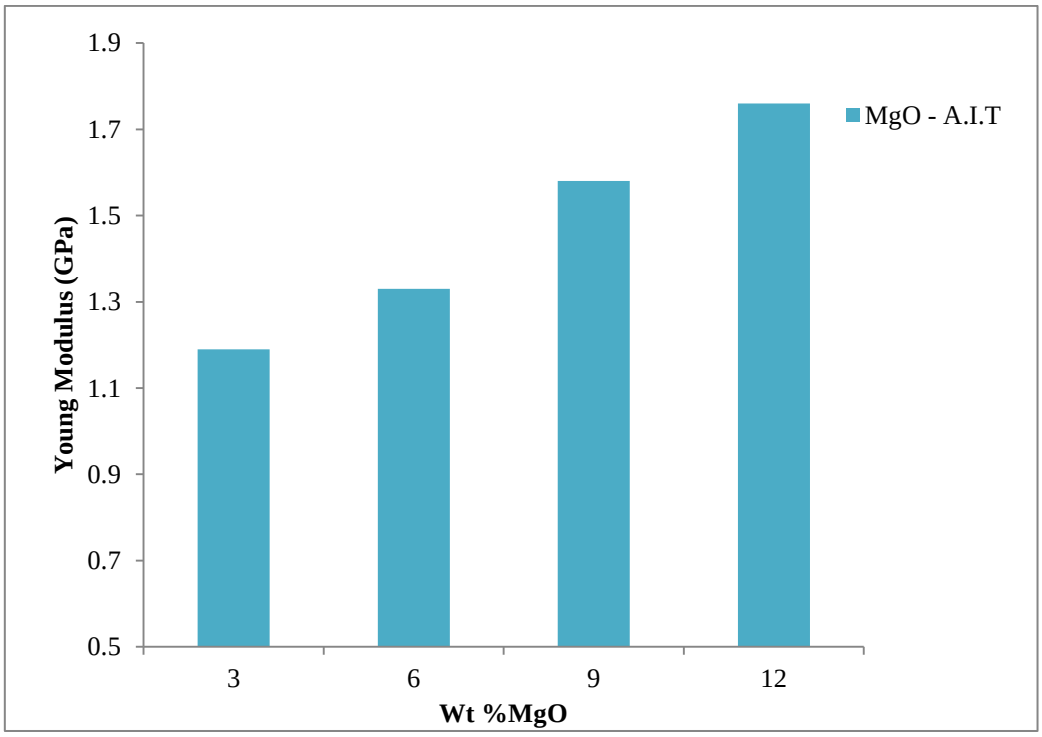


Figure 10-Young's modulus values with weighted fracture of MgO samples after immersion in diluted sulfuric acid for 10 days.

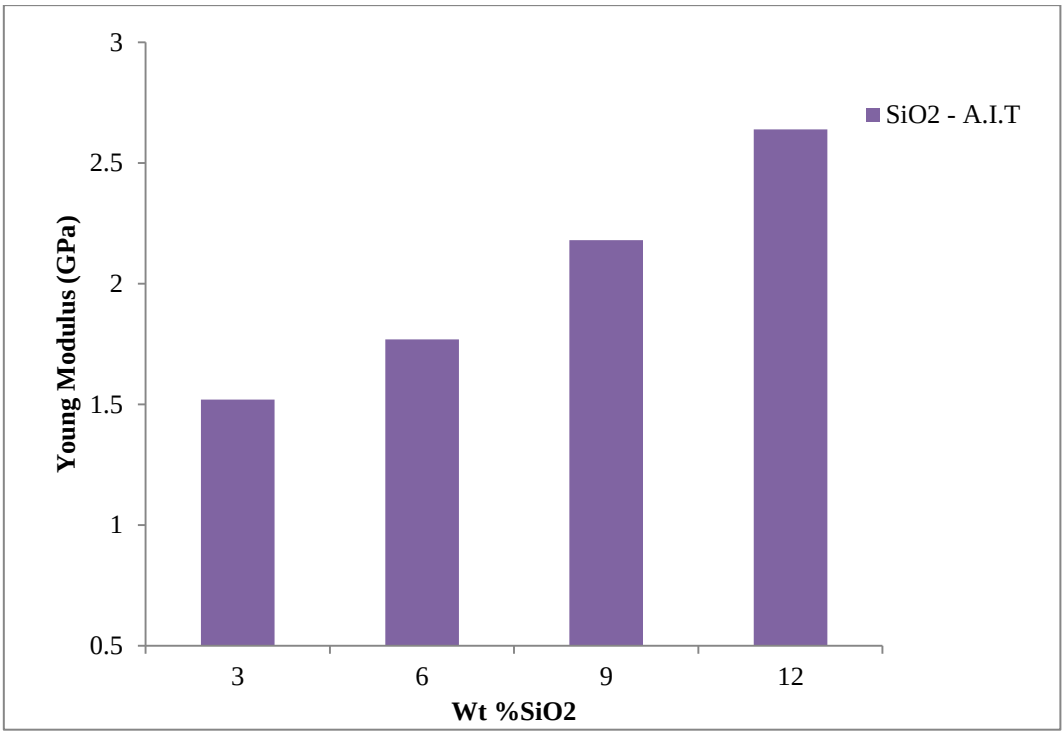


Figure 11-Young's modulus values with weighted fracture of SiO_2 samples after immersion in diluted sulfuric acid for 10 days.

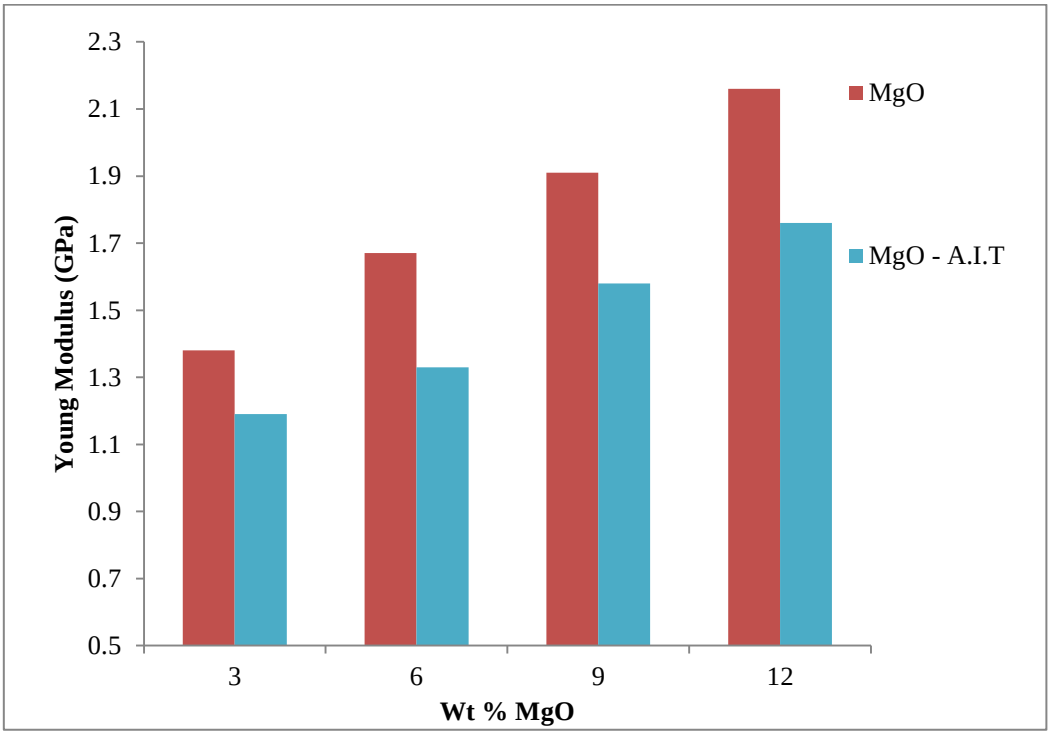


Figure 12-Comparison of Young's modulus values with the weighted fraction of MgO samples in normal conditions and after immersing in diluted sulfuric acid for 10 days.

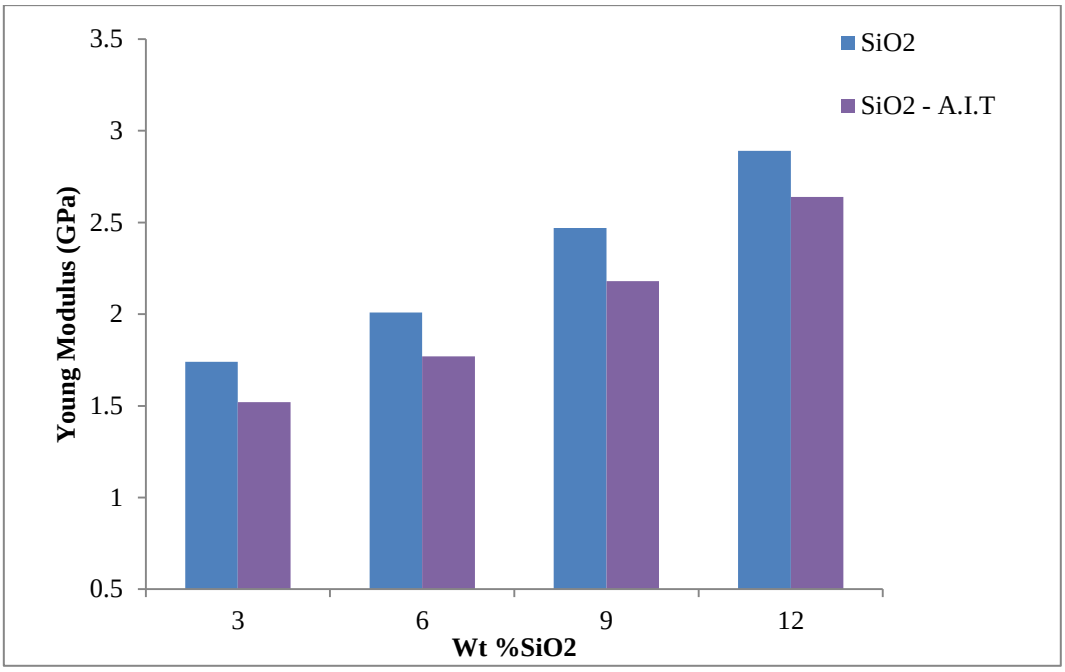


Figure 13-Comparison of Young's modulus values with the weighted fraction of SiO_2 samples in normal conditions and after immersing in diluted sulfuric acid for 10 days.

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