Procedia of Engineering and Life Science Vol. 8 No. 2 (2025)
Proceedings of the 8th Seminar Nasional Sains 2025
Universitas Muhammadiyah Sidoarjo

A Study Of The Properties Of An Epoxy Cotton Compound After Adding Silica Atoms In Different Proportions

Eng. Munadhil Kadhim Alomairy
{ mkh1884@gmail.com }

Islamic Azad University Kermanshah Branch Department of Mechanical Engineering,

southern technical university (stu) Iraq.

Abstract

Nano composites are a great discovery in the world of industry, which has developed rapidly in recent years as a result of searches for excellent alternatives to traditional metals in the production of materials, in which the defects of traditional ferrous and non-ferrous metals are visible as a result of their use. This leads to disasters in some large constructions, in addition to means of transportation that need surfaces free from corrosion and other negative phenomena. It also has many advantages such as reusability and environmental friendliness

Our current work is to prepare a composite material of cotton fabric reinforced with epoxy and Nano-silica atoms Moreover silica atoms or particles were used in different proportions, from 0.5%, 1% and 5% of the total weight of the epoxy by using a sensitive electronic balance, and then the mechanical properties according to the ASTM system were estimated. The results presented a clear improvement, about 0.5%, percentage. There is significant improvement in tensile stress, with 1% showed an improvement in the compression test

Keyword: *nano, epoxy, silica, fibers, woven, cotton*

1. Introduction:

The industrial use of composites has grown during the last decade. This increase is the result of these materials' distinctive features, which have few limitations on the choice of materials for applications like aerospace. Numerous studies on these cutting-edge materials have paved the way for future study and development. Composites are being used in a wide range of industries, which is really astonishing. Composites have excellent weight-to-strength and stiffness-to-weight ratios. These materials exhibit resistance in conditions when metals corroded.

One of the frequently discussed issues in the world of composite materials in recent years is how to increase the interlayer strength of multilayer composites. One of the best options is to use nanomaterials to enhance the interlayer properties of these composites, Which, in most situations, not only enhances the interlayer properties of these materials but also enhances other mechanical properties of composite materials. Research on the impact of various types of nanoparticles on the properties of composites is ongoing due to the large variety of nanomaterial and composite materials.

In many different sectors, including composite, epoxy resin is the most significant and often utilized material. Although the first epoxy resin was created in 1981, it wasn't until much later that it was marketed by two different researchers, Pierre Castan in Switzerland and Sylvan Greenlee in the United States. In fact, Kastan found that the reaction between diglycidyl A (DGEBA) and cyclic carboxylic acid anhydride results in resin production. The Siba Aji Basel firm in Switzerland created the first commercial resins for this substance in 1942, and they were introduced to the American market in 1946. (www.nano.ir) Epoxy resin research in recent years has concentrated on raising glass transition temperatures, boosting dimensional stability, and enhancing fireproof qualities (Ahmadi Fard, 2018). Chemical groups in epoxy resin have the following characteristics: Chemical resistance will be created by the ether bond. The epoxide ring is only found at the end of the chain, which is what creates the three-dimensional network,

Ramakrishna Malkapuram et al, reported, that natural fibers have distinct properties in chemical and physical properties. Olusegun David Samuel et al, found Ukam and sisal composites manufactured by hand lay-up process provide an opportunity of replacing existing materials with a higher strength, low cost and environmentally friendly.

Libo et al investigated the influence of alkali treated flax and linen fibers on mechanical properties.

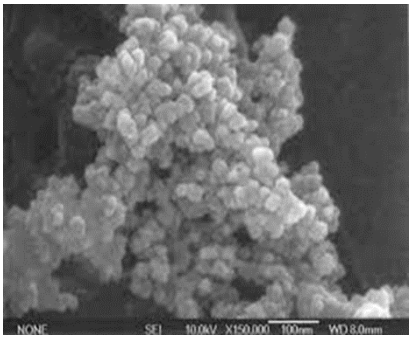


Fig .8 SEM image of Nano silica practical

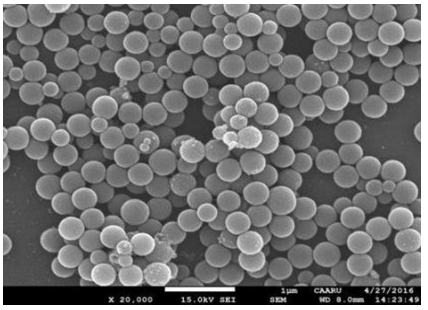


Fig .9. Nano silica powder Sio2

2. Experimental

2.1 Materials used:

For investigations of this work Cotton in the form of thin layers, which their thickness is 1 mm, and epoxy type KER828, Kumho Company, South Korea, with hardener and Nano-silica particles, with specifications of 99.8% Purity and VCN 1042 Product number 20-30nm diameter Literature Review

Cotton woven

Fig.1. Materials used for fabrication of composites

2.2 Resin preparation

In this investigation, an ultrasonic probe sonicator was used to prepare a modified epoxy resin with nano silica atoms of 0.5%, 1%, and 5% Wt%, respectively. The desired amount of Nano silica (Wt%) with the epoxy resin were taken into a separate beaker and allowed to vibrate for 3 hours in the ultrasonic probe so nicator and also the same blend was allowed to be kept in the rotary shaker for 30 minutes and 450 temperatures to ensure the better dispersion the epoxy and hardener were mixed and well stirred in the ratio of 10:1.

Fig.3.tensiltest for 0.5%silica teensiest for 1% silica —— teensiest for 5% silica

2.3 Composite fabrication

The test samples were prepared by manual labor using simple auxiliary means such as a metal table, brushes and wax because the wax prevents the adhesion of epoxy to the base of the table. After placing a thin layer of epoxy on the table with approximate dimensions of 30 * 30 cm, then placing the first layer of cotton with dimensions of 25 * 20 cm, and so on with 6 layers between Each layer and another quantity of epoxy The layers of cotton with epoxy were arranged in two different directions,

the first at an angle of zero, and the second arrangement at an angle of 45 degrees in opposite directions to obtain other properties that give different results towards improving the compound, and this was known after conducting tests in the comprehensive trial of the tensile and compression tests is then left for 24 hours to dry completely. By Using a laser cutting process with dimensions of 20 * 250 mm, the slices to be tested were obtained.

fig.2.Ultra sonic device

6 layers cotton with epoxy

3.Result and Disscussion

The cotton reinforced fibers epoxy added with nano silica composites were subjected to various mechanical testing and its mechanical properties were analyzed and compared.

3.1 Tensile properties

From the composite laminate, the specimens have been cut by using Lesar machine. According to the ASTM D3039 standard the tensile test has been carried out in universal testing machine**.**

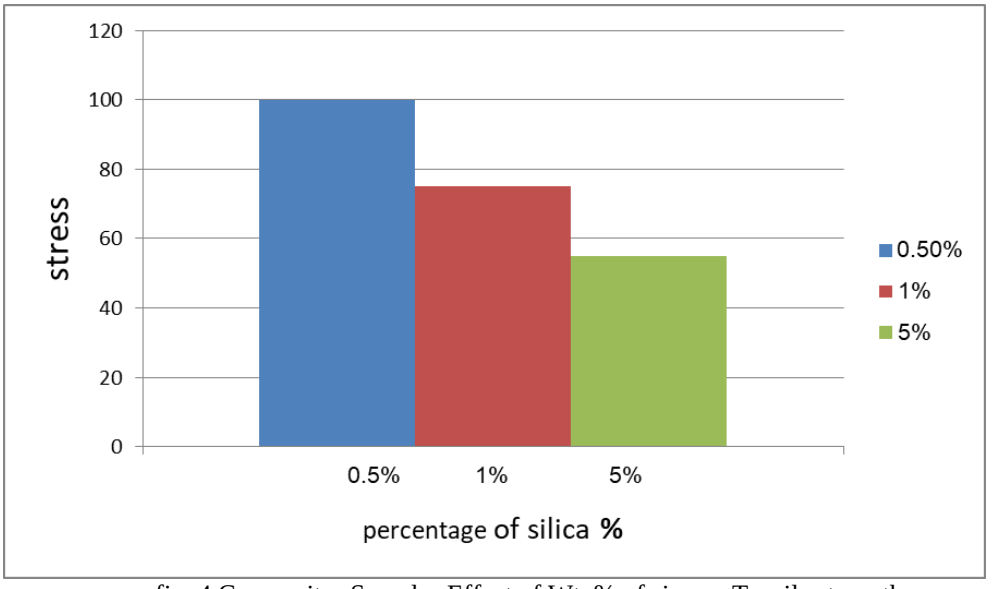


fig .4 Composites Samples Effect of Wt. % of sio_2 on Tensile strength

from the results presented in the diagrams above, it obvious that the epoxy compound with0.5% silica is the highest among the rest, and the lowest reading is 5% silica, which is shown in the third column, and this is evidence that the more additions did not improve the mechanical properties However, the percentage of 0.05% is better, and this can be explained by that is, the small increment in the amount of silica. The difference by adding silica to the cotton and epoxy compound, and the lack of improvement in the properties indicated by the defects of random distribution and agglomeration in places in a heterogeneous manner has a clear impact on this phenomenon.

3.2 Compressive properties

The compressive strength has been carried out according to the ASTM. D3039 standard. The results are plotted in the below graph.

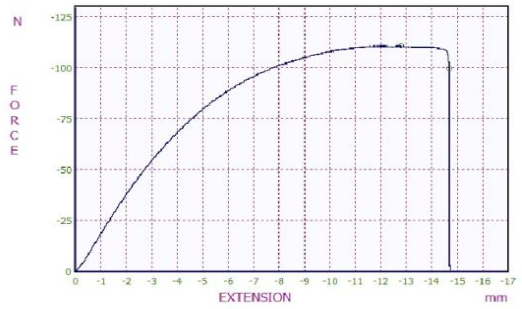


Fig 5. a. compressive test for 1%

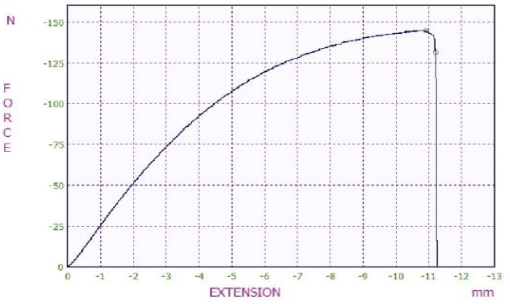


fig 5.b Compressive test for 5%

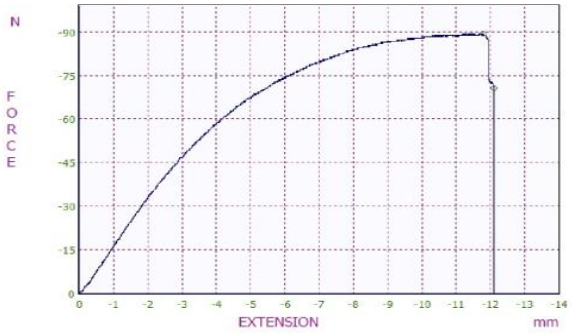


Fig 5.c. compressive test for 0.5%

fig.6 Composites Samples Effect of Wt. % of sio2 Compressive Strength

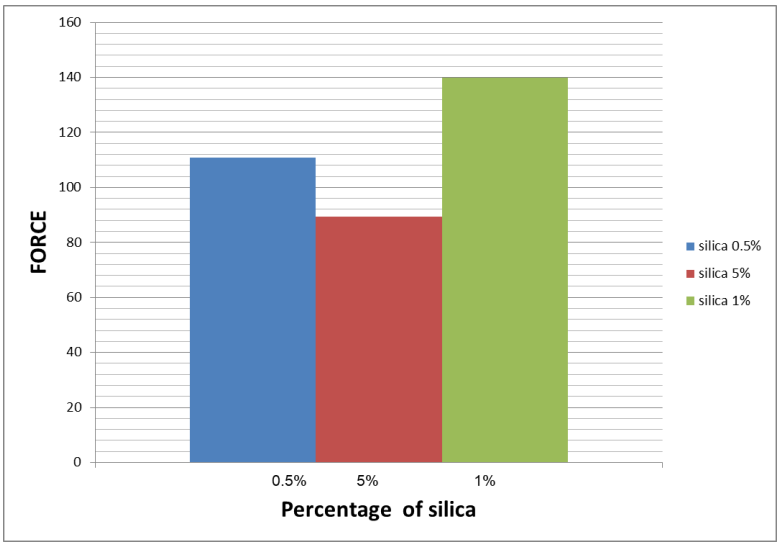
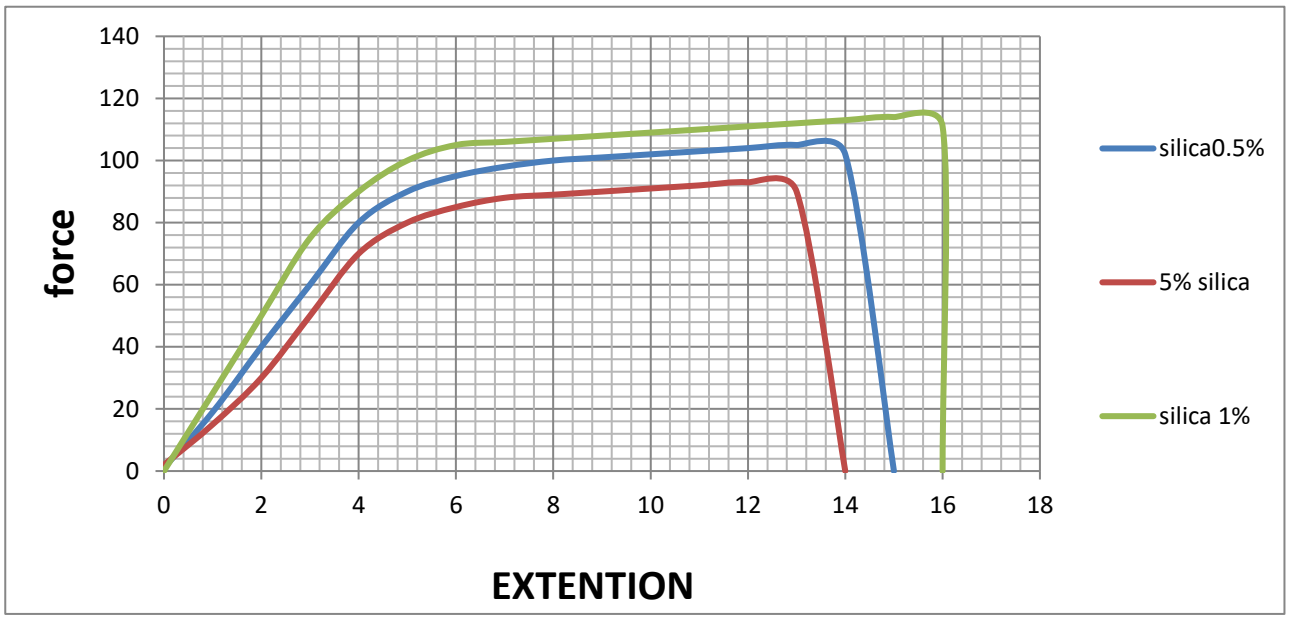


Fig .7. Compressive diagram for effect wt.% sio2



After looking in detail and reading the graphs and the column chart in Figures 5.6.and 7, we notice that the results are partially different from the results of the tensile test charts, due to the high reading of 1% silica , which showed that it had improved the compressive properties as a result of increasing the proportion of silica atoms and the uniform distribution that appeared due to it , The uniformity of silica particles, which means that the tests for one compound do not give similar tests As a result of careful examinations of the devices designated for this test . it shows that, the composite which is having 1% sio2 is suitable for better bear bending loads compare to 0.5% and 5% filled silica composites.

3.3 Toughness Results

Samples were taken from the charts of the tensile tests obtained after the Testing process, and the correct readings were taken from the Excel charts by obtaining the equation and then applying the rule of integration to the equation by taking the highest elongation reading as the highest value of the limits of integration and obtaining results according to all equations sequentially and according to Nano silica as a ratio.

One example to explain how we calculate the area under the stress strain curve.

$$\int_0^{13.2007} y = 105.25x + 828.61 = 20108.548 \frac{J}{M^3} \text{ (for 0.5\%silica)}$$

Table 1. Toughness resultant

Sio2 %	Orientation	Resultant
0.5%	0^0	28753.17 j/ m^3
0.5%	45^0	20108.548 j/ m^3
1%	0^0	2725.037 j/ m^3
1%	45^0	3345.02 j/ m^3
5%	0^0	11514.60 j/ m^3
5%	45^0	11451 j/ m^3

Conclusion

The main steps that we have implemented to get to know the benefits of one of the hydrophobic inorganic materials, which are considered Nano composites that other researchers have previously worked on after obtaining good and satisfactory results for the development of texture-based composite materials, The matrix material is natural textile cotton with epoxy. The tests that have been performed are tensile, compression and bending. The following conclusion are drawn.

-Increase in tensile strength was noticed in cotton epoxy reinforced composites having sio2 content of 0.5wt%. The maximum tensile strength has improved up to 21.26% with addition of 0.05%wt% of Nano silica.

-compressive load carrying capacity of the composite also increased gradually while increasing the wt% of Nano silica content 1% percentage.
-The ratio affects the results depending on the type of test and its interpretation. It is not possible to establish a single ratio that bears all the good characteristics.
-It was noted that the toughness test showed better results in adding 0.5% silica through the arithmetic result of 28753.17 j / m3.

Refrensi

Borassus Flabellifer (Asian Palmyra) fiber reinforced composite," Composites Part B: Engineering, vol. 55, pp. 479-485, 2013.
A. Haque, M. Shamsuzzoha, F. Hussain, D. Dean, S2-Glass/Epoxy polymer nanocomposites: manufacturing, structures, thermal and mechanical properties, Journal of Composite Materials, Vol. 37, pp. 1821-1837, 2003.

Ahmed Sahib Mahdi, Najah Rustum Mohsin " Water absorption and fatigue life of an Epoxy composite reinforced by glass fiber" International Conference on Materials Engineering and Science, 454, 2018

A. Mirzapour, M. H. Asadollahi, S. Baghshaei, M. Akbari, Effect of nanosilica on the microstructure, thermal properties and bending strength of nanosilica modified carbon fiber/phenolic nanocomposite, Composites Part A: Applied Science and Manufacturing, Vol. 63, pp. 159-167, 2014.
A. R. Beaber et al., "Nanostructured Sic by chemical vapor deposition and nanoparticle impaction," Surface & Coatings Technology, Vol. 202, pp. 871-875, 2007.

AL F Gorjani, G. M. S. Student, and A. Omidvar, "Investigation on Manufacturing Process and Mechanical Properties Wheat Straw/Recycled Polyethylene Composite," Pajouhesh and Sazandegi, 2007.

B. Yousif, A. Shalwan, C. Chin, and K. Ming, "Flexural properties of treated and untreated kenaf epoxy composites," Materials & Design, vol. 40, pp. 378-385, 2012.

C. Chen, R. S. Justice, D. W. Schaefer, J. W. Baur, highly dispersed nanosilica-epoxy resins with enhanced mechanical properties, Polymer, Vol. 49, pp. 3805-3815, 2008.

C. M. Thompson, H. M. Herring, T. S. Gates, and J. W. Connell, "Preparation and characterization of metal oxide/polyimide nanocomposites," Composites Science and Technology, Vol. 63, No. 11, pp. 1591-1598, 2003.

C. Scaiponi, "Hemp fiber composites for the design of a Naca cowling for ultra-light aviation," Composites Part B: Engineering, vol. 81, pp. 53-63, 2015.

C. Toumey, "Why not zwergo-technology?" Nature Nanotechnology, Vol. 6, p. 393, 07/06/online 2011.

D. Kim, S. Jeong, and J. Moon, "Synthesis of silver nanoparticles using the polyol process and the influence of precursor injection," Nanotechnology, Vol. 17, No. 16, p. 4019, 2006.

D. N. Bikiaris, A. Vassiliou, E. Pavlidou, and G. P. Karayannidis, "Compatibilisation effect of PP-g-MA copolymer on iPP/SiO2 nanocomposites prepared by melt mixing," European Polymer Journal, Vol. 41, No. 9, pp. 1965-1978, 2005.

KOLAHDOZAN, HAMIDEH. Seyed Saeed Nuri Khorasani, Seyed Mansur Bidaki. Sedigheh Vaezifar. 2008. Preparation and Determination of Properties of Nano-Silica Prepared by Sedimentation Method. Paint Industries Research Institute

Mohseni Shakib, Mohsen. 2010. Mechanics of Composite Structures. Tehran: Imam Hossein University. Institute of Printing and Publishing.

Motahari, Siamak, Abbas Naderi. 2003 Reinforcement of Composites Used in Marine Structures. 5th National Conference on Marine Industries of Iran

Masoumi, Bakhshali, Ali Akbar Entezami, 2010. Basics of Polymer Chemistry. Tehran: Payame Noor University

N. Samadi, "Dynamic Analysis of Targeted Beam Reinforced with Carbon Nanotubes." Msc Thesis, Razi University, 2011.