Evaluation of Tensile Properties of Nano-Silica einforced Hybrid Composites.

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Abstract: Composites are the materials which play an important role in many industrial applications. Many types of research are done on the fabrication and mechanical properties of composite materials. The new composite is fabricated by hand lay-up method in this work. The reinforcing materials which are in the form of layers of Kevlar and sisal fibers, polyester resin as a matrix and Nano silica as filler material are used. With the change in Nano silica wt % mixed in resin and fiber stacking sequence, different samples were prepared. The properties like tensile strength, tensile modulus were obtained.

Keywords: Kevlar fiber, sisal fiber, polyester resin, fabrication, reinforcing, Nano silica.

1) Introduction: A composite material is defined as a combination of two or more materials which gives better results when compared with individual components used alone. These are the materials having properties that are not found in nature, consisting of two or more chemically different constituents namely the polymer matrix and reinforcement. The matrix material binds the fiber reinforcement gives the composite component its shape and determines the quality of its surface.

Gujjala Raghavendra et al (1) studies on the mechanical and tribological behavior of Nanofiller reinforced polymer Nanocomposites. This study investigates the mechanical properties of jute and glass fiber. In this work, fiber is layered alternatingly and fly ash and aluminum are used for fabrication by mixing with epoxy resin.

M.Somaiah Chowdary et al (2) study the effect on Nano clay on the mechanical properties of the s-glass fiber. This work investigates the tensile and flexural properties of the synthetic fiber. The fibers are layered one upon the other and polyester resin is used with Nano clay mixed.

Ali Algahtani et al (3) studies that all fibers used in polymer engineering composites can be divided into two categories, namely synthetic fibers, and natural fibers. Synthetic fibers are the most common. Although there are many types of synthetic fibers, glass, carbon and aramid fibers represent the most important. Kevlar is an aromatic polyamide or aramid fiber introduced in the early 1970s by DuPont. It was the first organic fiber with sufficient tensile strength and modulus to be used in advanced composites. It has approximately five times the tensile strength of steel with a corresponding tensile modulus. Originally developed as a replacement for steel in radial tires, Kevlar is now used in a wide range of applications. It is a trade name for aramid fiber. The U.S. Federal Trade Commission gives a good definition of an aramid fiber as "a manufactured fiber in which the fiber-forming substance is a long chain synthetic polyamide in which at least 85% of the amide linkages are attached directly to two aromatic rings".

T. Padmavathi et al (4) Studies were carried out on sisal-epoxy composites prepared with different fiber weight fractions containing optimally treated (18% NaOH) sisal fibers, using an improvised fabrication approach. An enhancement of 110% in the optimally treated fiber tensile property resulted in improvement of composite mechanical properties (compression, tensile, interlaminar shear stress, and energy absorption) ranging between 18% and 158%. A novel fiber treatment effectiveness parameter was introduced, to quantify the translation efficiency of the enhanced fiber tensile property into the composite tensile property. Scanning electron microscopic analysis of fractured composite specimens is also presented and discussed.

2) Methodology:

2.1. Materials:

The woven mat Kevlar and sisal fibers were purchased from Go green product, Chennai. These fibers are used as the reinforcement of the composite. The mixture of polyester resin and Nanosilica powder, which was used as matrix material, was purchased from Go green products, India. The materials used in this work are shown in fig 2.1.1 and fig 2.1.2.


Figure: 2.1.1. Kevlar fiber


Figure: 2.1.2. Sisal fiber

2.2. Experimentation:

There are so many fabrication techniques were available in the manufacturing of composites. They are pultruding, compression molding, resin transfer molding, and vacuum molding are some examples. The hand layup fabrication technique is one of the simplest, easiest and reducing manufacturing method for manufacturing composites. The main advantage of the hand layup fabrication technique is ease of fabrication of large and complex materials with less strain and low manufacturing time. In Addition to these benefits, it requires simple equipment and tooling that are less expensive. Different steps to be taken while fabricating the composites are a collection of fibers and resin, preparing of mold, making, and extraction of the composite from the mold. The dimensions of the mold are restricted to 200mm*170mm*3mm. At the starting stage of fabrication, the base plate and mold is cleaned by the thinner solution. Now the surfaces of mold and base plate are allowed to dry after cleaning it with a thinner and the wax has to be applied to the base plate and mold sheet for the easy removal of the specimen. After that, the fibers are cut down to the mold dimensions and then take the polyester resin which is mixed with the nano-silica. The weight percentage of nano silica is varied in 1wt%. 2wt%, 3wt%. Now the polyester resin, catalyst, accelerator are mixed in the proportion of 100:1.5:1.5 and place the fibers in the mold sheet and apply resin. This process is continuing up to four layers of fiber. After preparing the different laminates by changing the layer sequence of fibers a weight is placed on the laminates. After 24 hours the weight is removed and the cured specimens are removed, cleaned & inspected. The layering sequence of fibers is presented in table 1.

Figure: 2.2.1. Composite mold.

Figure: 2.2.2. Tensile test specimen

2.3. Mechanical testing of composite:

A digital micrometer is used for measuring the thickness and width of the composite mold. The ASTM standard for tensile specimens is ASTM D-638M-89. The length of the tensile specimen was 160*12.5*3mm. The tests were conducted by tensometer containing load capacity of 2000kgs, elongation 0-200mm and accuracy 0.001. Both the ends of the specimen are fitted in both the clamps in order to get the result accurately. After the test is conducted note the readings displayed on the digital screen.

Figure: 2.3.1. Tensometer used for testing tensile

Figure: 2.3.2. Tensile specimen after testing

3. Results and discussions:

3.1. The weight percentage of fiber and matrix:

layering sequence	Wt.% of fibers		Fiber weight fraction(%) in composite	Polyester resin weight fraction(%) in composite
	Kevlar	Sisal		
KSKS	50	50	26	74
SKKS	50	50	26	74
KSSK	50	50	26	74

3.2 tensile strength and tensile modulus values:

Composite sample	Tensile strength (Mpa)	Tensile modulus (Gpa)
KSKS+1wt. % Nano silica	99.46	3.09
SKKS+1wt. % Nano silica	100.2	3.51
KSSK+1wt %Nano silica	97.17	3.50
KSKS+2wt% Nano silica	107.2	3.38
SKKS+2wt% Nano silica	116.5	3.83
KSSK+2wt.% Nano silica	128	3.59
KSKS+3wt% Nano silica	102.98	3.58
SKKS+3wt% Nano silica	104.53	3.48
KSSK+3wt% Nano silica	113.54	3.64
Polyester resin	19.76	2.36

3.3. Results:

The maximum tensile strength and tensile modulus are obtained at 2 wt % of Nano silica. Tensile strength maximum is obtained at KSSK stacking sequence of fiber. The maximum tensile modulus is obtained at SKKS stacking sequence of fiber. The strength of the fiber increases from 1 wt % to 2wt% of Nano silica and decrease from 2 wt % of Nano silica. This change in strength and modulus is due to the change in Nano silica wt %. Here maximum viscosity ranges up to 2 wt %. as the viscosity decreases at 3 wt % the strength and modulus values also decreases.

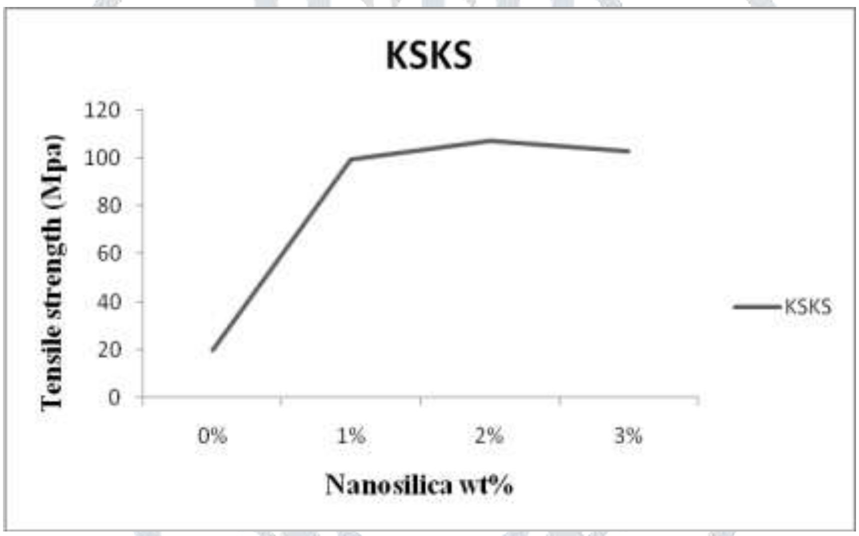

Figure: 3.3.1 Tensile strength in KSKS with variation in Nano silica wt. %

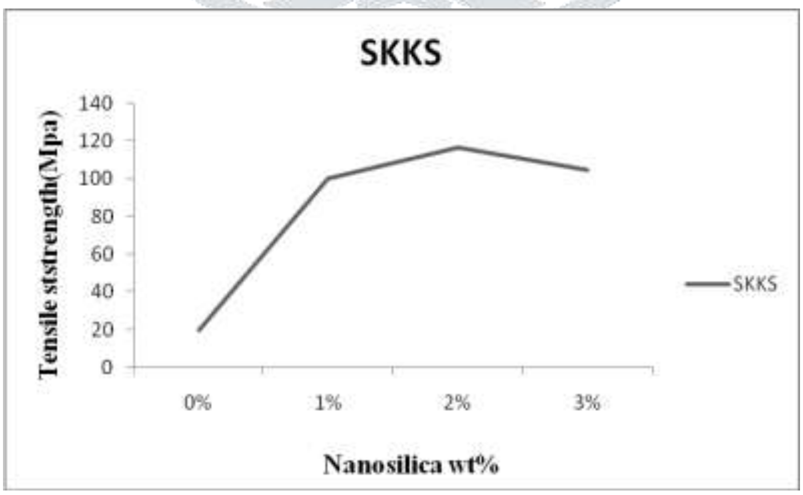

Figure: 3.3.2. Tensile strength with the stacking of SKKS with variation in Nano silica wt%

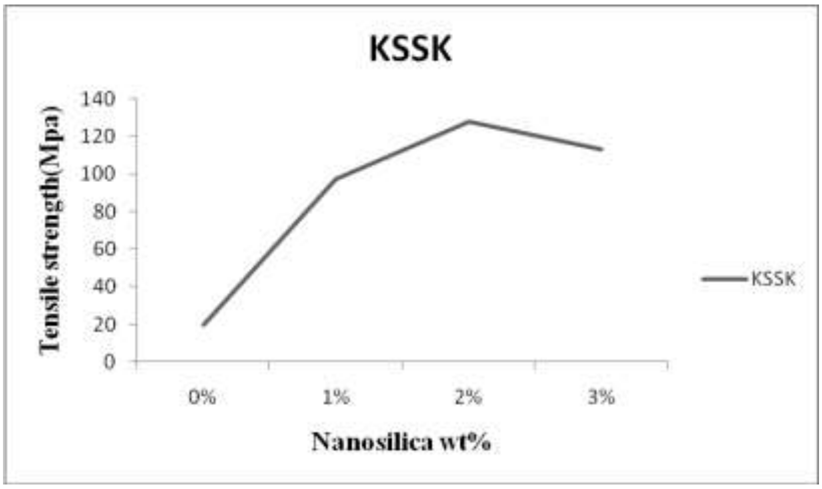

Figure: 3.3.3. Tensile strength with the stacking of KSSK with variation in Nano silica wt%

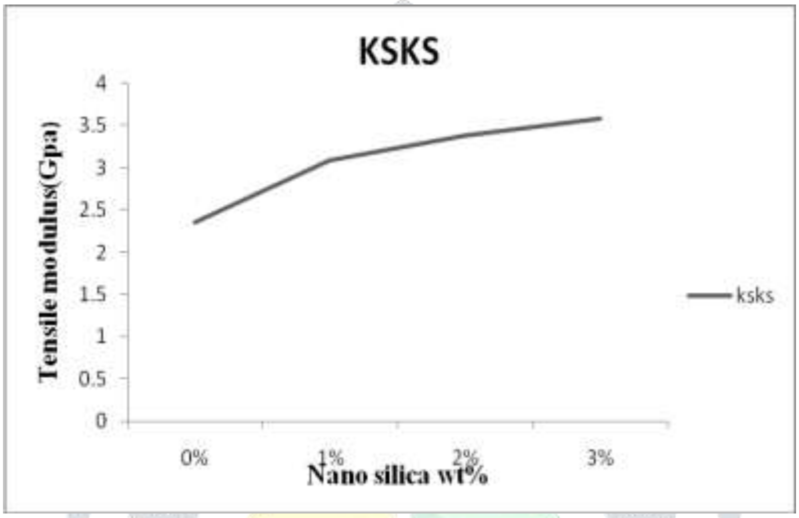

Figure: 3.3.4. Tensile modulus with stacking of KSKS with variation in Nano silica wt%

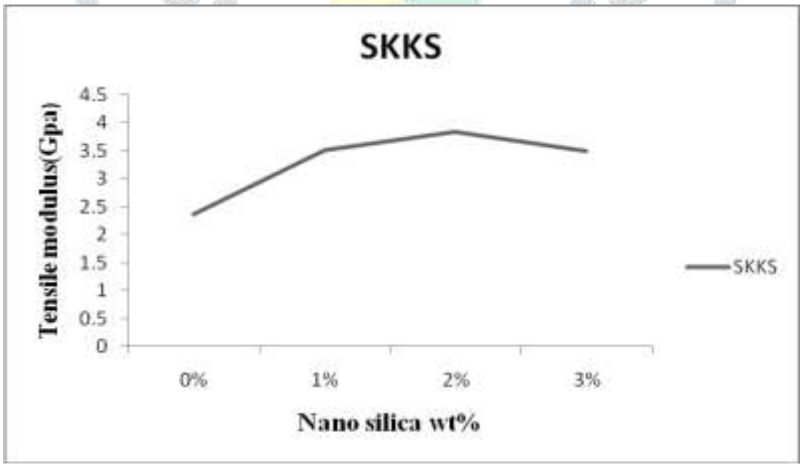

Figure: 3.3.5. Tensile modulus with the stacking of SKKS with variation in Nano silica wt%

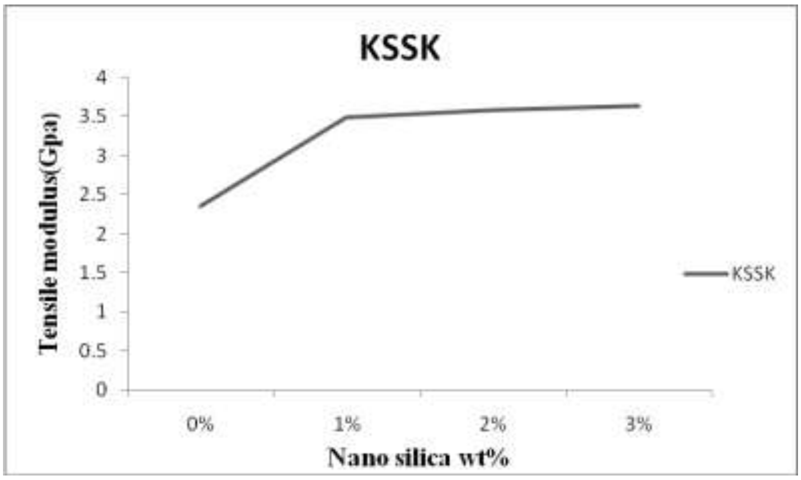

Figure: 3.3.6 Tensile modulus with the stacking of KSSK with variation in Nano silica wt%

4. Conclusion:

In this work, we prepare different mold with sisal fiber, Kevlar fiber and Nano silica with 1%, 2%, and 3 wt %. Among all the combination we have obtained maximum tensile strength at 2 wt. % of Nano silica at KSSK stacking sequence of fiber. We observe maximum tensile modulus at 2 wt. % of Nano silica at SKKS stacking sequence.

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