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Preparation and study of mechanical and thermal properties of an epoxy composites with isobutyl rubber: Damaged water taps powder and signals

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***Abstract*---**Through this research, polymeric composites were prepared from epoxy as a base material with isobutyl rubber (waste rubber washers powder for water taps) and this was done by adding different weight percentages of isobutyl rubber**.** This was done by adding different weight percentages of isobutyl rubber. After a series of experiments, it was found that the best weight percentage was (5%).This addition was done at different temperatures (8,25,55) °C. The results when compared before and after the reinforcement process for the composites showed that the thermal conductivity decreased after the reinforcement process, as for the resistance to hardness and compressibility, it increased after reinforcement, but it was less valuable for the hardness and compressibility at the temperature (55) °C compared to the results at (8) °C. As for the shock resistance, its value increased after reinforcement, and the increase was greater at the temperature (55) °C compared to its value at (8) °C.

***Keywords*---**epoxy, isobutyl rubber, thermal conductivity, mechanical properties.

Introduction

Insulating materials can be added to resin materials in the form of reinforcing materials in different proportions in order to change their properties and obtain

new, more efficient properties and properties that need to be changed as needed. Shock resistance, compression, hardness, thermal conductivity and other properties. (Al-Mousawi, Ali Ibrahim, 2011), as the researcher (Hani, 2008) studied the mechanical properties of the composite material resulting from adding epoxy resin to the natural rubber paste, and the researcher noticed an increase in the mechanical properties values after cementing. The researcher (Al-Mayali, Khaleda Hussein, 2010) conducted a study on the effect of ultrasound on some mechanical and rheological properties of synthetic rubber. In this study, some properties such as compressibility, flexibility and some physical properties were measured. It was found that there is a mutual effect between the polymer and solvent molecules, which was reflected in the increase in the values of these properties.

The researcher (Al-Rawi, Ibrahim, 2014) studied some mechanical properties of the composite of epoxy with magnesium oxide, where a composite material with a polymeric basis was prepared by hand casting method. The composite material was prepared from epoxy resin as the base material and the reinforcement material was magnesium oxide, and the researcher noticed the increase in the values of mechanical properties after the reinforcement.

The researcher (Ahmed, et al., 2017) also studied the mechanical properties and physical properties of a polymer mixture of epoxy resin with urethane rubber with a percentage of 15% by weight of rubber. The study showed that there is a direct relationship between tensile and shock resistance and thermal conductivity with increasing lifespan (0_28) days and on the opposite of hardness, which decreases with increasing lifespan. The researcher (Mohammed, Abdul Rahman Rashid, 2019) also studied the effect of direction, volume fractions and temperature on the flexural strength property of polymeric sheets reinforced with glass fibers. The results showed that increasing temperatures of Heat increases the bending strength of epoxy samples with glass fibers, unlike polyester samples reinforced with glass fibers, where the bending strength decreases with higher temperatures.

Experimental part

The materials used in the research

Base material

Epoxy is the base material from (Sikadur_32 normal) company, with a density of (1.4) kg / liter and a white color. As for the hardener Dark gray color (3_amino methyl-3,5,5,-tri methyl hexyl amine) The hardener is added to the epoxy in a ratio of (1:2) at room temperature to obtain the samples required for molding.

Reinforcing materials

Isobutyl rubber was used in the form of wast rubber rings powder for water taps.

Procedure

A quantity of wast rubber rings for water taps was taken, then the grinding process was carried out by exposing the material to liquefied nitrogen. After freezing, the material was manually ground into a powder of suitable size for the required mold casting process. Thus, the reinforcing material is ready for use. Epoxy resin was used, then the hardener mentioned previously was added to it in a ratio of (1:2) to obtain a gelatinous substance at room temperature. The models were prepared by using the manual molding process before and after the reinforcement using different weight ratios of the reinforcing material. Isobutyl rubber () 5%,10%,15%,20%,25%,30%,35%,40%,45%,50%,55%, 60%) then placed the overlapping material in molds designated for each measurement according to the special specifications. After the casting process is completed, the material is left for 24 hours at different temperatures (8,25,55) C to complete the solidification and overlapping process. And the homogeneity that exists between the existing molecules.

Sample preparation

Hardness test samples

Where the hardness device (Shore_D) type (Durometer Shore) was used; Which was supplied by the German company "Wolpert", and was used to measure the hardness of samples of polymeric materials.

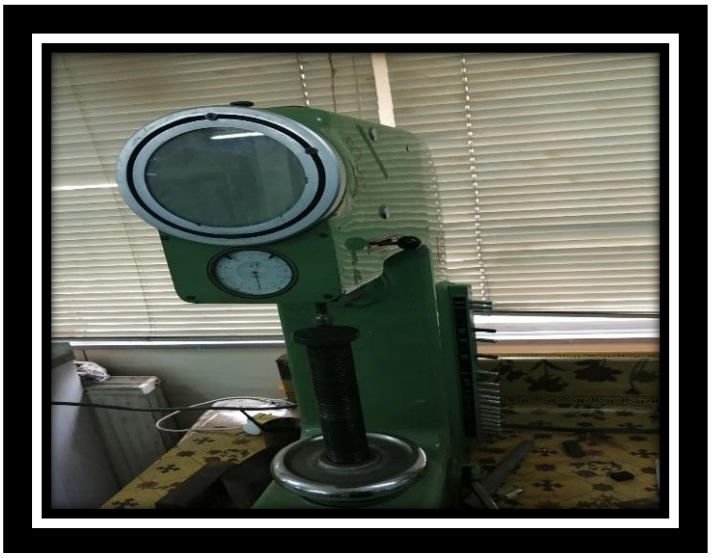

Figure (1) Hardness Testing Apparatus

Shock Test samples

The models in this test were prepared according to the American specifications (ASTM_D256_87). The groove angle is (45) degrees, in front of the grooving depth is 2 mm, and the dimensions are (10 * 10 * 55). Where the absorbed energy

sufficient for the occurrence of the fracture is obtained in the charpy Impact Instrument, which is supplied by the (Tokyo kokiseizosho,LTD company

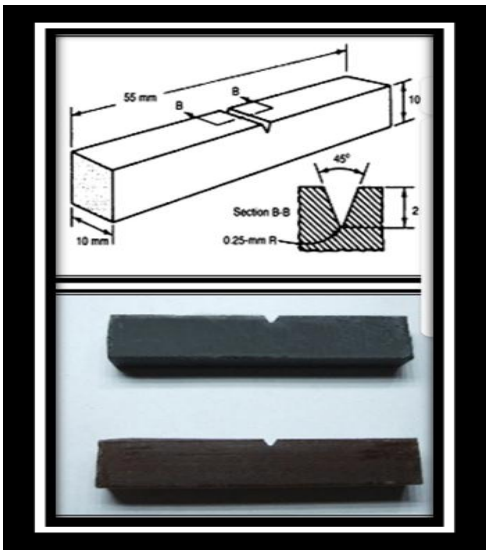

Figure (2) The shape of the shock test sample

Compression test samples

The samples for this test were prepared according to the required specifications (ASTM_D618), where a hydraulic piston (Testing Machine CO_LTD) was used, and it has a cylindrical shape according to the specifications supplied by (WOLPERT_Germany) company.

Heat conduction

Samples (11.23 cm) in diameter and (1 cm) in thickness were used in this test, as shown in Figure (3).

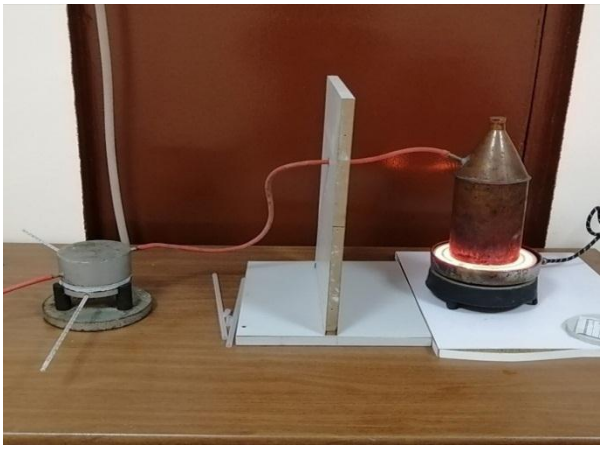

Figure (3) Thermal conductivity coefficient measuring device

Results and Discussion

Hardness

Plastics are subjected to scratching by equipment that is harder than it during use in applied fields, so the hardness property is one of the most important surface mechanical properties, as it is known as the material's resistance to penetration, scratching and deformation (Al-Rawi, Roaa Essam, 2019). Figure (4)

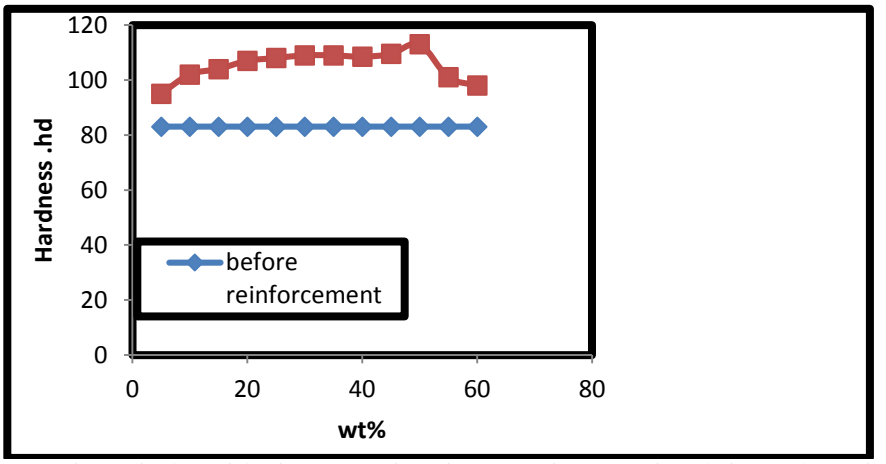

Figure (4) The relationship between hardness values and weight ratios of epoxy before and after reinforcement at 25°C

From Figure (4) it appears that the highest value of hardness at the weight ratio (5%) of the reinforced material, three samples are prepared at the same weight ratio of the reinforced material and then the first sample is left at (8) C, the second sample at (25) C, and the third sample at (55) m as in Figure (5)

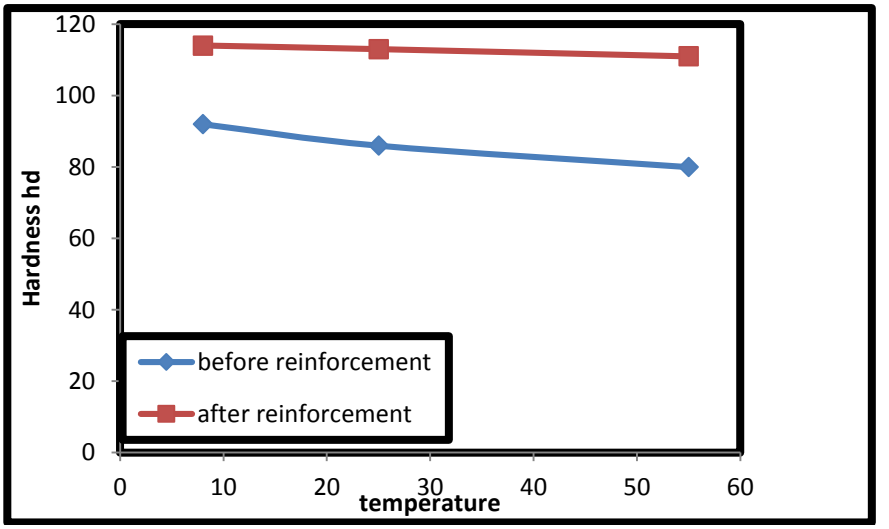

Figure (5) The relationship between the hardness and temperature values of the epoxy before and after the reinforcement process

We note that the hardness values have improved after reinforcing the epoxy, and the reason for this is the increase in the cross-linking between the epoxy and isobutyl rubber, thus reducing the molecular movement of the polymer and resulting in an increase in the hardness and an increase in the resistance to deformation. (Al-Rawi, Ibrahim, 2019), the hardness values of polymeric composites decrease with the increase in temperature and the reason for this is due to the fact that hardness is a measure of polymer deformation that the material can suffer under the influence of external stress, the higher temperature, the softer the material due to the movement of the elementary units that make up the material and the breaking of the bonds, which leads to a weak resistance to scratching (Hull, 1981).

Shock resistance

The shock test is very important from a practical point of view, because through it, it is possible to calculate the absorbed energy needed to break the sample used in the research, as this value is given directly from the examination device, through which the shock resistance can be calculated according to the relationship: Gc=Uc/A
Gc: the shock resistance of the material (joules / m^2)
Uc: Energy required to break the sample (Joules)
A: Cross-sectional area of the sample (m^2), (Adnan et al., 2017) Figure (6)

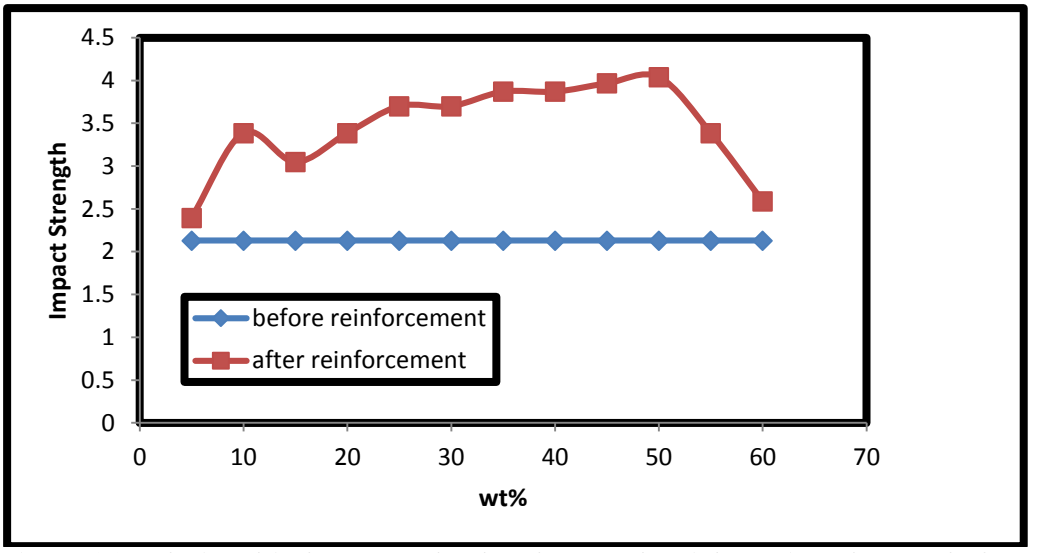

Figure (6) Relationship between shock values and weight ratios of epoxy before and after reinforcement at 25 °C

Then three samples are taken at the weight percentage (5%) and left for 24 hours at different temperatures (8,25,55) C. Figure (7)

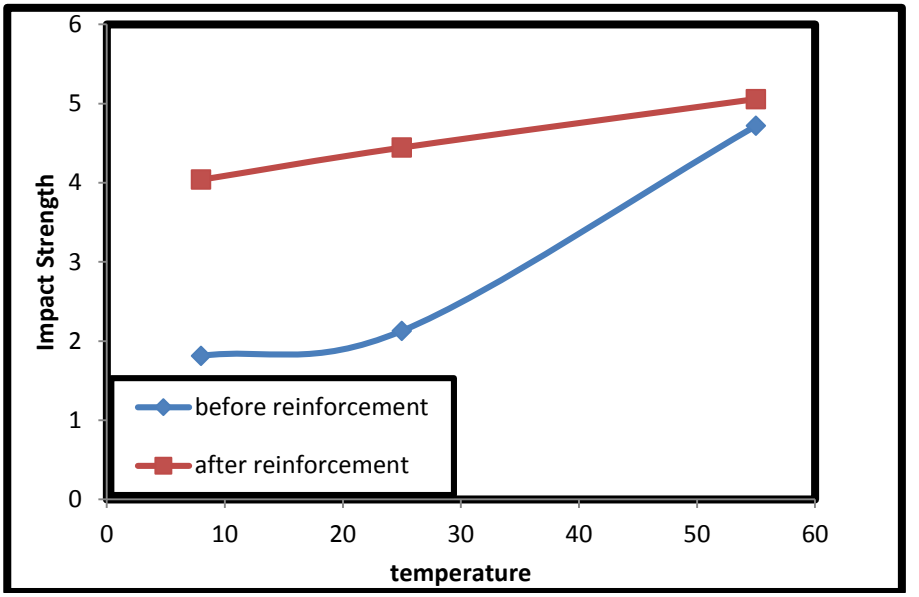

Figure 7: The relationship between the shock and temperature values of the epoxy before and after the reinforcing process

We note that the process of reinforcing with isobutyl rubber led to an increase in the shock resistance of these materials in general, and the shock was little for the resins due to their fragility, but after it was reinforced, the shock values increased significantly, and the reason for this is that the rubber bears the largest part of the stress applied to the base material (epoxy). Where the presence of rubber prevents the growth of small cracks that occur as a result of the trauma (Al-Moussawi, Ali, 2009).

Compressibility

It represents the bearing of the material under study for the pressure applied to it without breaking or shattering, and this load is called the compressive load. This test is widely used to examine brittle materials and thermosetting polymers because these materials have greater durability than others (Al-Hadidi, Taher Jaafar, 1990). The compression can be calculated by means of the load applied to the unit area of the initial cross-section, as in Figure (8) (Shukla, Shankar, 2011).
C Compression (Mpa) = Force(N)/Area(m2)

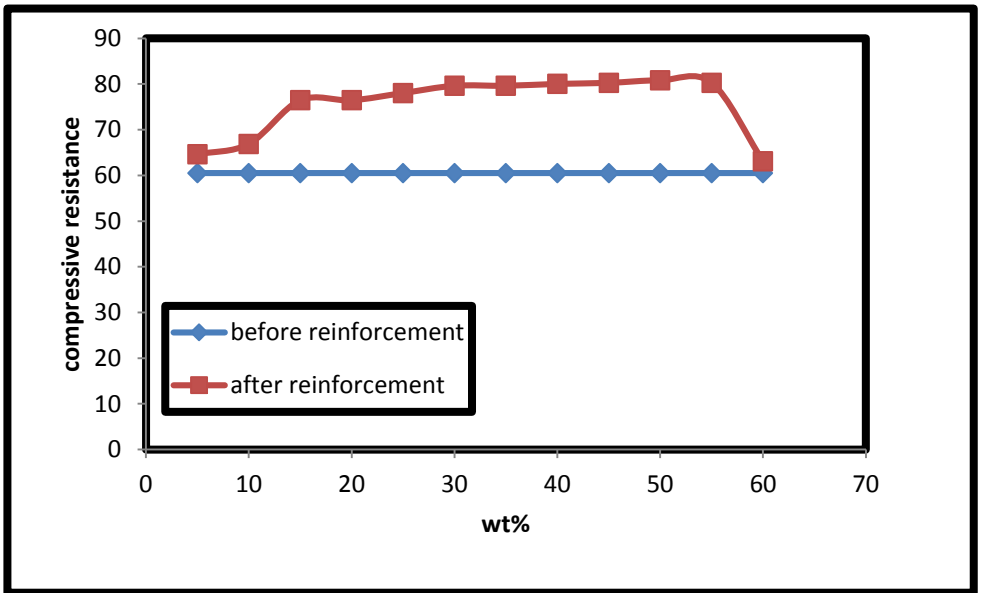

Figure (8): The relationship between compressive strength and weight ratios of epoxy before and after reinforcement at 25°C

Three samples are taken at the weight ratio of the fortified material (5%) and the samples are left for 24 hours at different temperatures (8,25,55) °C Figure (9)

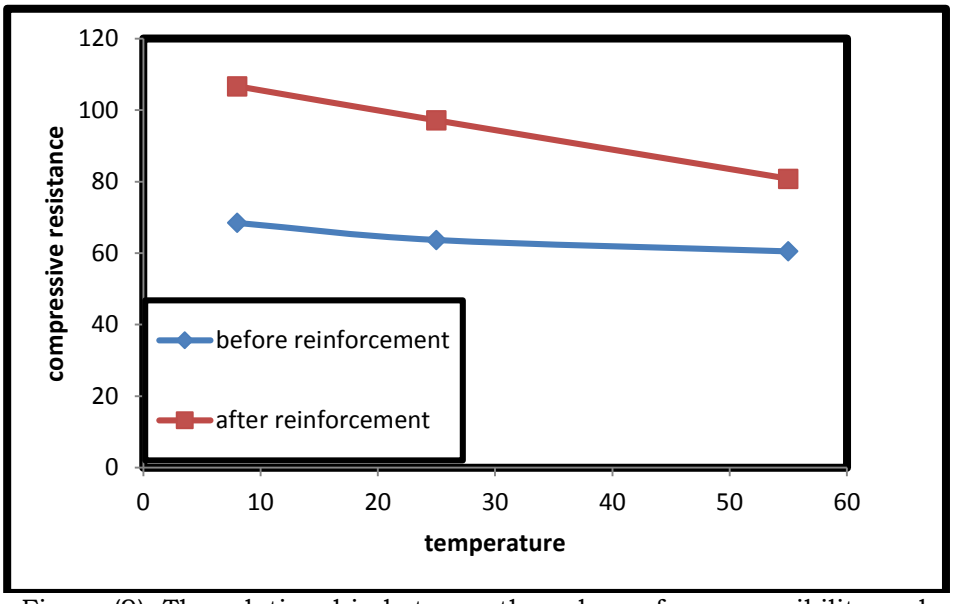

Figure (9): The relationship between the values of compressibility and temperature before and after reinforcement

We note that the base material (epoxy) reinforced with rubber has a higher compressive strength than non-reinforced epoxy, as the epoxy's resistance to compression increases with the increase in the amount of rubber (Al-Jubouri, Al-

Mousawi, 2009). It is also noticed that the compressive values decrease with increasing temperature due to the breaking of bonds and the weak bonding strength between the base material and the particles of the reinforced material, which leads to making the resin softer and weakening its resistance to compressive load.

Thermal conductivity

Thermal conductivity is a measure of the extent of the material's ability to conduct heat, when there is a difference in temperature between the ends of the measured material, an amount of energy will be transferred along that material. Therefore, thermal conductivity is known in the form of the amount of heat traveling during one second divided by the temperature slop. Thermal conduction varies according to the material. In solid materials, the movement is carried out by the oscillation of atoms or molecules from one location to another accompanied by a change in temperature. The conductivity also varies depending on whether the material is a conductor or an insulator, in the conductive material, the free electrons and photons are responsible for the transfer of energy, but in the insulating material, energy is transmitted by photons only (Akram, Sinai, 2009) Figure (10)

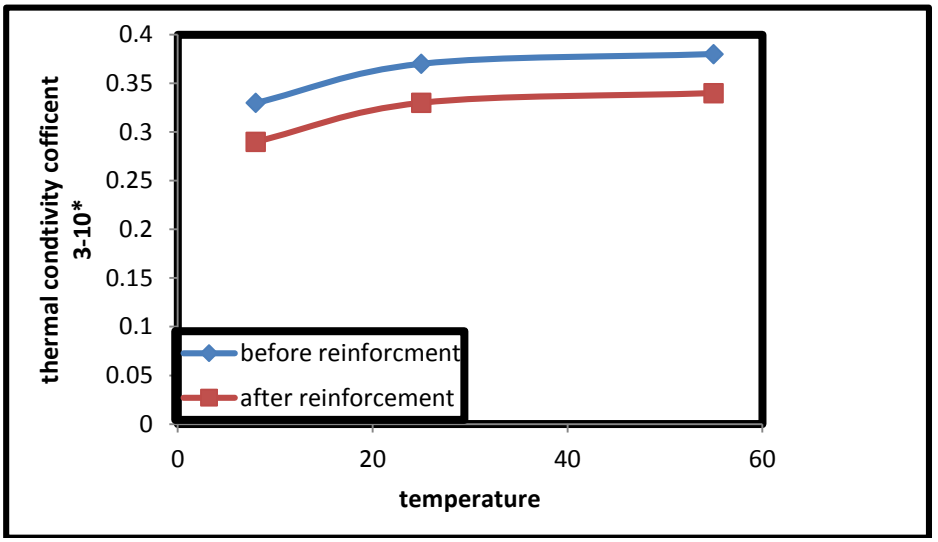

Figure (10): The relationship between the thermal conductivity values and the temperature of the epoxy before and after the reinforcing process

Thermal conductivity rises with the increase in temperature and the reason for this is due to the vibrations in the internal structure of the resin, which increase with the increase in temperature and decrease when adding the reinforced materials, because the reinforcing material works to impede the vibration and thus the low value of the conductivity (Najla, et al., 2013).

Conclusions

When you add isobutyl rubber (waste rubber washers powder for water taps) as a reinforcing material to the epoxy (substrate). It will affect the mechanical and physical properties; the hardness, shock and compressibility will increase after the reinforcement process. But the thermal conductivity decreases after reinforcing compared to the results before reinforcing. Both hardness and compressibility are inversely related to temperature, the values of hardness and compressive strength decrease with increasing temperature, except for shock, its value increases as the temperature rises and decreases with decrease in temperature.

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