EFFECT OF REINFORCED ALUMINIUM OXIDE NANOPARTICLES IN EPOXY COMPOSITES

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ABSTRACT

In the present work Aluminium oxide nanoparticles were successfully synthesized by a sol-gel method and Aluminium tri-chloride were used as the precursor material. Ethanol and Ammonia it helps to make a stoic metric solution to get Aluminium oxide nanoparticles. Aluminium oxide nanoparticles were reinforced at 0.001wt % in epoxy composites to determine the hardness and density. It was found that the density was increased with decreases in the size of the nanoparticles. The hardness also increased with decreases in the size of the nanoparticles.

Keywords: Nanoparticles, sol-gel method, Aluminium tri-chloride, Epoxy, Hardness, Density.

Introduction

Aluminium oxide is known as an important non-oxide ceramic with high melting point (2072 ºc), high hardness, high wear resistance, low thermal expansion. . This properties make Aluminium oxide an attractive candidate material for many applications such as grinding materials, polishing paste, and wear resistant. Epoxy resin has been of significant importance to the engineering community for many years. Components made of the epoxy-based materials have provided outstanding mechanical, thermal and electrical properties and ease of processing. The important factors influencing performance architecture, curing conditions and the ratio of the curing agent. Using an additional phase (e.g., inorganic fillers) to strengthen the properties of epoxy resins has become a common practice. The use of these fillers has been proven to improve the material properties of epoxy resins. Building on the fact that the micro-scaled fillers have successfully been synthesized with epoxy resin.

Experimental Procedure

The Aluminium source used in this research was Aluminium Tri-chloride (Alcl3). Also ethanol (99.99%) was used as solvent and Ammonia (28%) as catalyst. The solution was prepared by mixing 1.3 gm of Alcl3, 100 ml of ethanol, 100 ml of water and then. 28% of ammonia was added drop wise to stirred ethanoic solution of aluminium tri-chloride(0.1M). The gel was let to stirred for 30hr at room temperature. After filtering, drying at 100 ºc for 24 hr in an oven, and annealing at 1000 ºc in Muffle furnace. Epoxy and Hardener mixed in proper proportions by using spatula. This stirring is done about 20 minutes. Apply wax on the lateral surface of rectangular pan. Wax is applied in order to avoid the sticking of epoxy after the solidification and also gives smooth surface of the solidified epoxy. Epoxy is applied on the lateral surface of the rectangular pan in the form of thickness 20mm. Epoxy is placed in ambient conditions for 3min. Aluminium oxide Nano-particles is sprinkled uniformly on the surface of the epoxy layer. Later another layer of epoxy is applied on the Aluminium oxide Nano-particles and allows it to solidify. After 36 hours, the obtained composite material is tested to hardness number by Rockwell hardness testing machine.

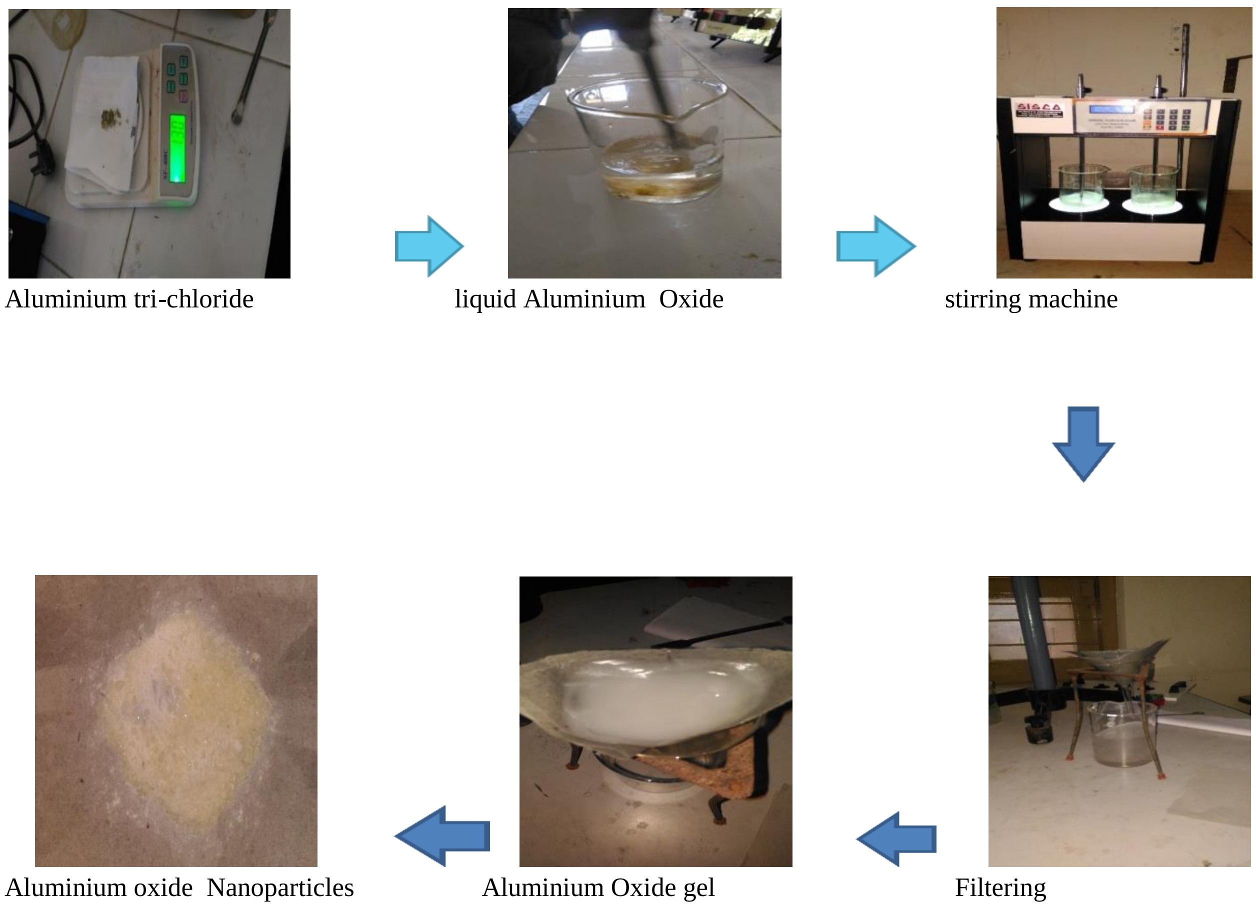

Figure1. show the Aluminium oxide nanoparticles. These particles were synthesized by sol-gel technique. The precursor material used here is Aluminium tri-chloride (AlCl3). Ethanol and Ammonia used as solvent and catalyst respectively.

Fig.1.Aluminium oxide nanoparticles

Figure2. show Epoxy and Hardener mixed in proper proportions by using spatula. This stirring is about 15-20 minutes. Interruption in stirring may cause solidifying the epoxy in the hardener before applying the Aluminium oxide nanoparticles in its matrix.

Fig.2.Epoxy-hardener mixture

Figure3. Show applying wax on the lateral surface of rectangular pan. Wax is applied in order to avoid the sticking of the Epoxy to the lateral surface of the rectangular pan. Waxing also helps in easy removal of epoxy after the solidification and also gives smooth surface of the solidified epoxy.

Fig.3.Applying wax

Figure4. show epoxy is applied on the lateral surface of the rectangular pan in the form of layer of thickness 20mm. Epoxy is placed in ambient conditions for 3min.

Fig.4.Forming epoxy layers

Figure 5. show the dispersion of the Aluminium oxide nanoparticles on the epoxy layer. Aluminium oxide nanoparticles are sprinkled on the epoxy throughout the area. This is done at ambient conditions for 20 minutes and allow it for solidification.

Fig.5. Aluminium oxide nanoparticles on Epoxy layer

Figure 6. shows the reinforcing the Aluminium oxide Nano particles in the matrix of two layered Epoxy composites.

Fig 6 Double layered Nano particles on Epoxy

Figure7. Shows clearly the dispersion of Aluminium oxide Nano particles in between the two epoxy layers after solidification. Then this specimen is cut transection to observe the Nano particle layer in between the epoxy

Fig 7. Transection view of two layered epoxy composites

Figure8. show the Rockwell hardness testing machine testing the hardness number of epoxy compositions with dispersion of single layers Aluminium oxide Nano particles. We take red scale reading as hardness number. Taking the hardness number with respective to the load shown in Table 1 &Table 2

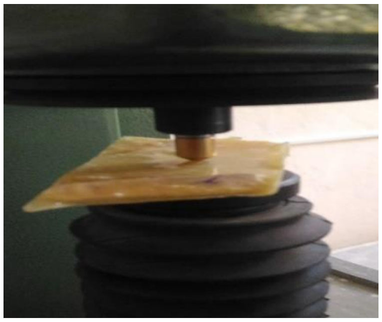

Fig 8. Rockwell Hardness testing machine

Result and Discussions

Table1. Shows the reading of the hardness number of the epoxy layers which are reinforced by the Aluminium oxide nanoparticles with respective to the applied load with wt% 0.002 Aluminium oxide nanoparticles

S.no	Wt % of Aluminium oxide nanoparticles	Density	Load	Hardness no
1	0.002	3.67	60	22
2	0.002	3.67	100	17
3	0.002	3.67	150	12

Table 1. Hardness varying with applied load

Table1. Shows the reading of the hardness number of the epoxy layers which are reinforced by the Aluminium oxide Nano particles with respective to the applied load with wt% 0.001 Aluminium oxide nanoparticles

S.no	Wt % of Aluminium oxide Nano particles	Density	Load	Hardness no
1	0.001	3.67	60	21
2	0.001	3.67	100	15
3	0.001	3.67	150	11

Table 2. Hardness varying with applied load

Conclusion

From the experimental work the following major conclusion were drawn:
The density of the aforesaid Epoxy composites was increased with decrease in the size of nanoparticles. The hardness also increased with decrease in the size of Nano particles. The hardness increased the wt% of Aluminium oxide nanoparticles and density also increase with increasing the wt% of Aluminium oxide nanoparticles

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