The Effect of Fly Ash Carbon on the Mechanical and Thermal Conductivity Properties in Thermally conductive Adhesives

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Abstract

Thermal conductive adhesives are used for use in electrical boards and IC cooling and for attaching heat sinks or electric lamps. Fly ash is a substance consisting of carbon and some inorganic oxides. This material is obtained from the outlet of steelmaking furnaces (SL/RN). The purpose of this article is to use Fly ash and graphite as two carbon additives to improve thermal properties in thermally conductive adhesives. The based conductive adhesive that is used consists of epoxy resin as a binder and some nano oxides as filler. Characterization of fly ash and graphite modified adhesives was measured by SEM, XRD, thermal conductivity, and Lap-shear tests. The results show that fly ash can be a very suitable additive to increase the thermal conductivity of thermal adhesives. It doubles the thermal conductivity without changing the electrical conductivity. This is while graphite also increases thermal conductivity in the same range, but it creates electrical conductivity that can cause discharge in the board. Fly as increase thermal conductivity about two it greatly increases the thermal conductivity without increasing the electrical conductivity. Moreover, using fly ash as additive has a great environmental importance, because it is considered as a bypass of the steelmaking furnace.

Experimental method

Materials

The following materials were used in this research. Two-component epoxy polymer from the company, the first component is resin and the second component is hardener. TiO2, ZnO and SiO2 powders (in two dimensions, micron with an average of 200 microns and nano with an average of 30 nanometers) were purchased from Purian Chemical Company.

Analyses

Lap-shear test

To measure the apparent shear strength of the adhesive in the butt joint, the milk lap test according to the ASTM D 1002 standard is used. To perform this test, 316L stainless steel sheet with dimensions of 101.6 × 25.4 × 32 mm was used. After cutting the samples, the part of the sheet that is supposed to be coated with glue is surface cleaned. They are first sanded with 100 to 600 grit and then washed with alcohol. An area measuring 12.7 × 4.25 mm2 from the polished edge of the sheet is covered with glue. Tensile test was done by Instron 8802 machine in Shahrood University of Technology.

Drop angle test

The drop test is performed by measuring the angle of the water drop on the coating surface. The drop angle is measured with the Tensiometer IFTS.

Transparency test

The transparency test is qualitatively and visually checked by comparing the samples.

Self-cleaning test

In this test, samples are contaminated with graphite. In this way, graphite is rubbed on their surface. Then the samples are placed at an angle of 45 degrees and with water droplets that are controlled from above on the surface

Results and discussion

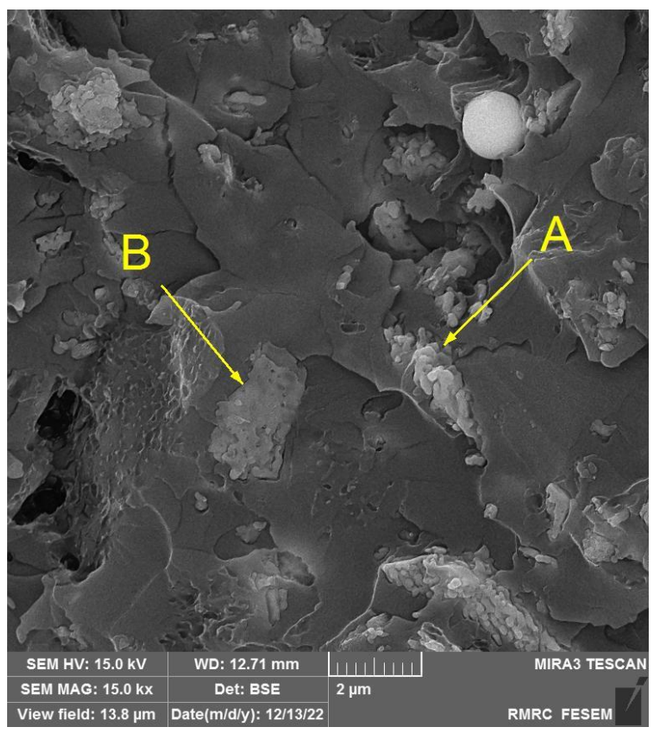

Fig.1.Epoxy/8%Al2O3/10% Fly ash

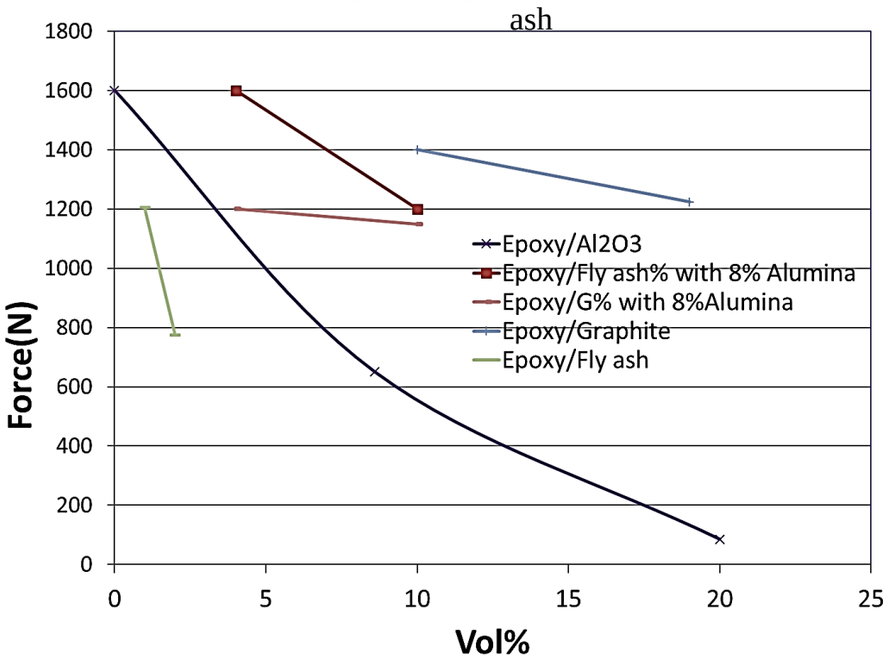

Fig. 2. The result of lap-shear test

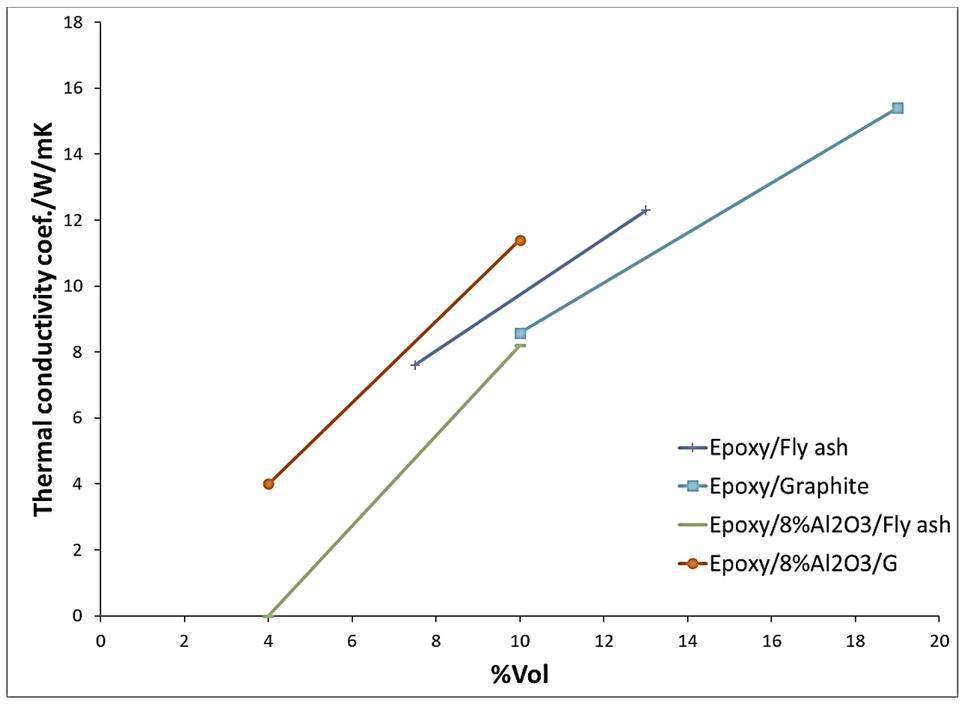

Fig.3. The result of thermal conductivity

Conclusions

In this research, different fillers were used in epoxy to obtain a thermally conductive adhesive. The results of shear strength showed that composites made of all powders decrease in shear strength when embedded in epoxy. The reason is that there is no covalent or ionic bond between the powder and the substrate, which means that the more powder we add to the composite, the result of our shear strength decreases.

The best shear strength among the samples was observed in SiO_2 and the lowest in alumina (Al_2O_3). But in terms of thermal conductivity, the samples containing alumina had much higher conductivity than the silica samples. Because in the production of thermal conductive adhesives, the parameter of the thermal conductivity coefficient is more important, therefore, in the production of hybrid samples, the combination of alumina with graphite or fly ash in combination with epoxy was used to increase the thermal conductivity. Graphite has a slightly higher conductivity than fly ash, but graphite also has electrical conductivity, so a spark may be produced when adding graphite. But when adding fly ash, the possibility of electric spark is lost. Therefore, the composite containing 8% alumina and 10% fly ash is the best example.

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