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Effect of Particle Size Variations on the Tribological Properties of Porcelain Waste Added Epoxy Composites

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Abstract : Epoxy based materials have advantages in tribological applications due to their unique properties such as light weight, self-lubrication capacity and wear resistance. On the other hand, their usage is often limited by their low load bearing capacity and low thermal conductivity values. In this study, it is aimed to improve tribological and also mechanical properties of epoxy by reinforcing with ceramic based porcelain waste. It is well-known that the reuse or recycling of waste materials leads to reduction in production costs, ease of manufacturing, saving energy, etc. From this perspective, epoxy and epoxy matrix composites containing 60wt% porcelain waste with different particle size in the range of below 90μm and 150-250μm were fabricated, and the effect of filler particle size on the mechanical and tribological properties was investigated. The microstructural characterization was carried out by scanning electron microscopy (SEM), and phase analysis was determined by X-ray diffraction (XRD). The Archimedes principle was used to measure the density and porosity of the samples. The hardness values were measured using Shore-D hardness, and bending tests were performed. Microstructural investigations indicated that porcelain particles were homogeneously distributed and no agglomerations were encountered in the epoxy resin. Mechanical test results showed that the hardness and bending strength were increased with increasing particle size related to low porosity content and well embedding to the matrix. Tribological behavior of these composites was evaluated in terms of friction, wear rates and wear mechanisms by ball-on-disk contact with dry and rotational sliding at room temperature against WC ball with a diameter of 3mm. Wear tests were carried out at room temperature (23–25°C) with a humidity of 40 ± 5% under dry-sliding conditions. The contact radius of cycles was set to 5 mm at linear speed of 30 cm/s for the geometry used in this study. In all the experiments, 3N of constant test load was applied at a frequency of 8 Hz and prolonged to 400m wear distance. The friction coefficient of samples was recorded online by the variation in the tangential force. The steady-state CoFs were changed in between 0,29-0,32. The dimensions of the wear tracks (depth and width) were measured as two-dimensional profiles by a stylus profilometer. The wear volumes were calculated by integrating these 2D surface areas over the diameter. Specific wear rates were computed by dividing the wear volume by the applied load and sliding distance. According to the experimental results, the use of porcelain waste in the fabrication of epoxy resin composites can be suggested to be potential materials due to allowing improved mechanical and tribological properties and also providing reduction in production cost.

Keywords : epoxy composites, mechanical properties, porcelain waste, tribological properties
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