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Dry sliding wear behaviour of organo-modified montmorillonite filled epoxy nanocomposites using Taguchi's techniques

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ABSTRACT

The aim of the research article is to study the dry sliding wear behaviour of epoxy with different wt.% of organo-modified montmorillonite (OMMT) filled nanocomposites. An orthogonal array (L_9) was used to investigate the influence of tribological parameters. The results indicate that the sliding distance emerges as the most significant factor affecting wear rate of epoxy nanocomposites. Experimental results showed that the inclusion of 5 wt.% OMMT nanofiller increased the wear resistance of the epoxy nanocomposite significantly. Furthermore, the worn surfaces of the samples were analyzed by scanning electron microscopy (SEM) to study the wear mechanisms and to correlate them with the wear test results.

1. Introduction

In recent years, polymer is extensively utilized in tribological components such as cams, brakes, bearings and gears because of their self-lubrication properties, lower friction and better wear resistance. The inherent deficiency of polymers could be altered successfully by using various special fillers (micro to nano sized particles). More and more polymer composites are now being used as sliding components, which were formerly composed only of metallic materials. Nevertheless, new developments are still under way to explore other fields of application for these materials and to tailor their properties for extreme load-bearing and environmental temperature conditions. The current global nanocomposite market size is around US$ 300 million and is expected to exceed US$ 1billion within the next 5 years [1,2]. Currently, clay filled nanocomposites account for almost 25% by volume of total nanocomposites usage and their market share is rapidly increasing.

Much research has been carried out in the development of nanoparticles filled composites through the incorporation of nano-scaled materials such as ceramics and carbon in polymer matrices. For instance organoclays [3], carbon nanotubes [4], alumina nanoparticles [5] and nano ZnO and nano SiC nanoparticles [6] have been added to polymers. Most studies on the influence of filler material in case of polymer composites sliding against metallic countersurface have been reported on the reduction of wear rate and coefficient of friction, in addition to higher mechanical strength obtained due to the addition of fillers in polymer composites. The wear was considerably reduced by the addition of different fillers in thermoplastic polymers [7–10].

In recent years the mechanism of filler action in reducing the wear rate of polymers has recently been a subject of intense study. However the microfiller filled polymer composites usually need quite a large amount of fillers to achieve better wear resistance, but in these composites some inherent defects are inevitable. Considering the disadvantages caused by microfillers, utilization of nanoparticles would be an optimum alternative. Since the predominant feature of nanoparticles lies in their ultra-fine dimension, filler atoms can reside at the interface and lead to a strong interfacial interaction if the nanofillers are well dispersed. As a result, the nanocomposites coupled with a great number of interfaces could be expected to provide exceptional tribological performance [11]. Since nanofillers can bring value added properties to the polymers, nanocomposites can become an important member in the family of wear-resistant and friction reducing materials. In filled polymer composites, the particle size plays an important role in the improvement of wear resistance.

Recent investigations on the tribological behaviour of organoclay filled polyamide6 (PA6) by Srinath and Gnanmoorthy [12] and Dasari et al. [13] show a low friction and high wear resistance since the size of nano additives is of the order of surrounding polymer chains and increases the bonding of particle to the polymer matrix. Nanoparticles tend to produce a tenacious transfer layer on the counterface, which protects the composite surface from direct contact with the counterface thereby reducing friction and

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