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Short communication

Tribological studies of polymer based ceramic–metal composites processed at ambient temperature

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ABSTRACT

Use of composite material is increasing due to economical processing of complicated shapes in large quantities. Addition of fiber/particulates improves the composite strength. In the current study, the tribological characterization of polymer based particulate composites which are processed at room temperature are investigated. The friction and wear behavior of polystyrene reinforced with steel powder (polymer–metal), alumina powder (polymer–ceramic) and a mix of steel and alumina powders (polymer–metal–ceramic) have been investigated under dry sliding conditions using a pin-on-disc tribometer. Tests were conducted at different normal loads and sliding velocities at room temperature. Coefficient of friction and wear loss during the wear tests are determined. Presence of metal and ceramic particulates affects the tribological behavior of the composite. The rise in temperature of the pin during sliding was measured. The rise in contact temperature is influenced by the composition which in turn influences the wear behaviour. The polymer–ceramic composite exhibits the lowest wear rate among the materials investigated.

1. Introduction

Polymers exhibit low coefficient of friction compared to metals due to their low interfacial adhesion energy. Polymers are reinforced with various fillers (metals, ceramics and fibres) to improve the strength and stiffness of the matrix. These fillers are expected to improve the tribological behaviour. The tribological behavior of such composites depends upon a number of material properties such as shape, size, distribution of particulates and composition as also on operating conditions such as load, speed, temperature, environmental conditions and the counter surface.

Prior investigations on polymer based systems include study of sliding wear of epoxy compounds [1] against different contact surfaces under dry and aqueous conditions. Jacobs et al. [1] report sliding wear behavior of neat epoxy filled with a fixed amount (20 vol%) of PTFE, graphite, MoS_2 and SnS_2 powder, and fixed quantity (15 wt.%) of carbon and glass fibers. It was seen that PTFE and carbon fibers reduced the wear of neat epoxy. Kishore et al. [2] have investigated the effect of type and content of fillers in epoxy–glass composite systems. The epoxy resin was filled with varying weight percent of graphite powder, HTBN rubber and E-Glass fibre. It was found that the increased percentage of graphite had reduced the wear rate. Prehn et al. [3] studying the effect of addition of silicon carbide particulates and carbon fibres have shown that as the particle size of the filler is reduced, the tribological properties of the composite are found to improve. Aravind Singh et al. [4] have proposed a model for the estimation of pin–disc interface temperature

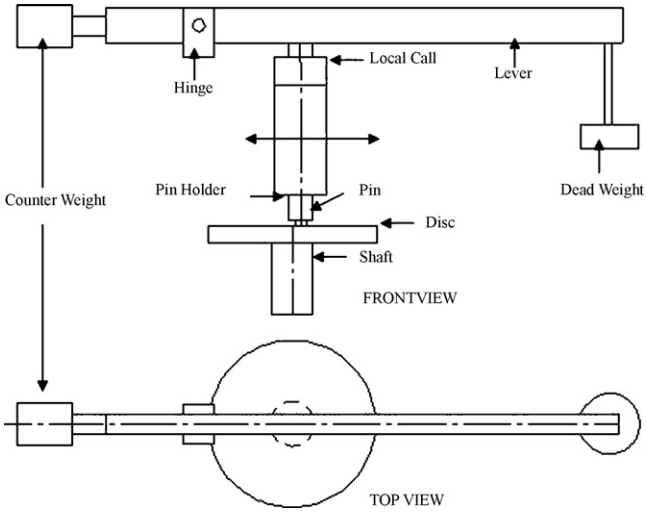

Fig. 1. A schematic diagram of pin-on-disc tribometer.

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by measuring temperature at two points along the axis of a pin. The effect of temperature on the wear behavior of metal matrix composites has been discussed by Dwivedi et al. [5] and a large change in the extent of wear at a critical sliding temperature has been reported.

No systematic investigation has been reported on the tribology of polymer based composites with particulate additions. In this report we present the results of the investigation of tribological behavior of polystyrene reinforced with particles of steel and ceramic.

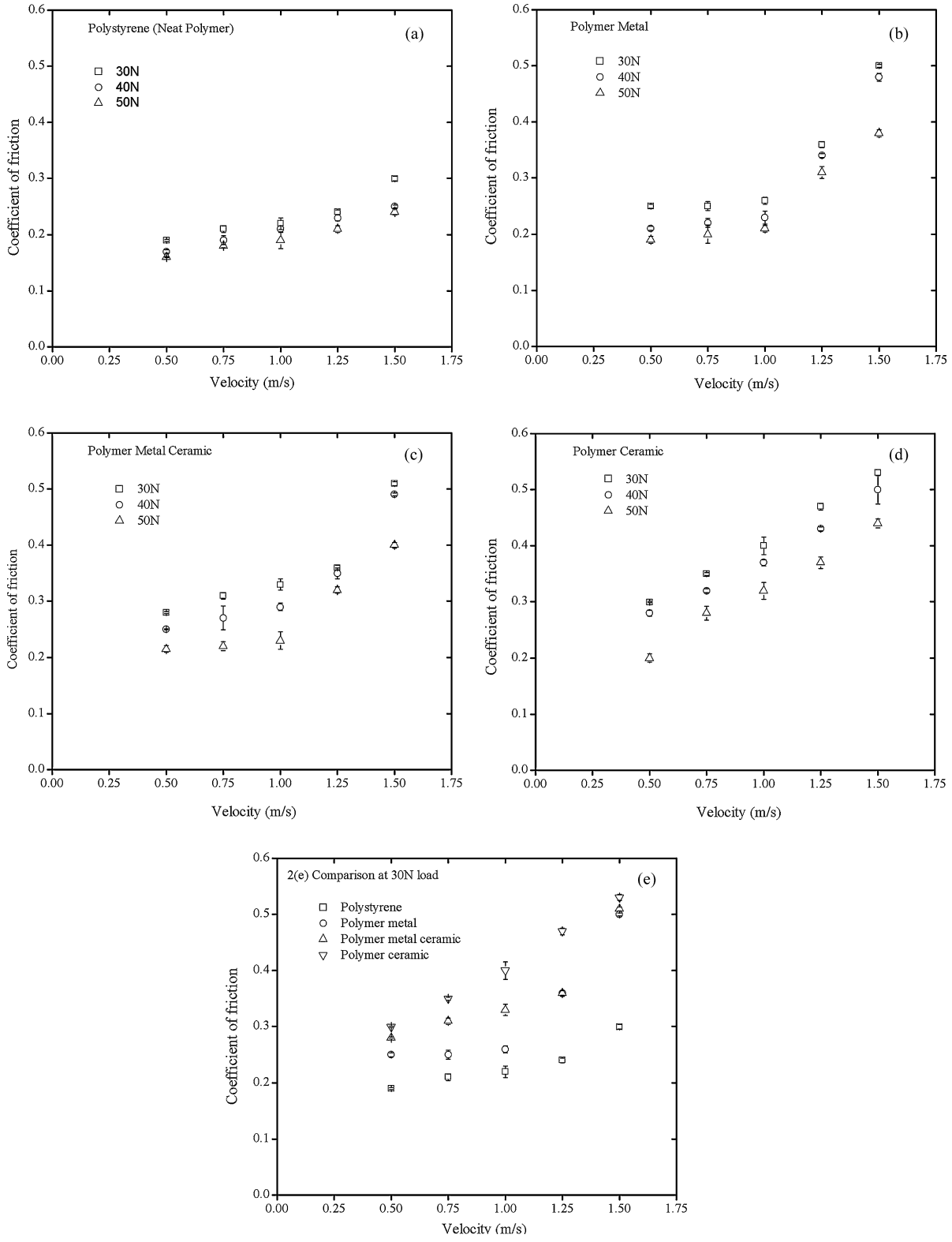

Fig. 2. Variation of coefficient of friction as a function of velocity and load for the neat polymer and different composites.