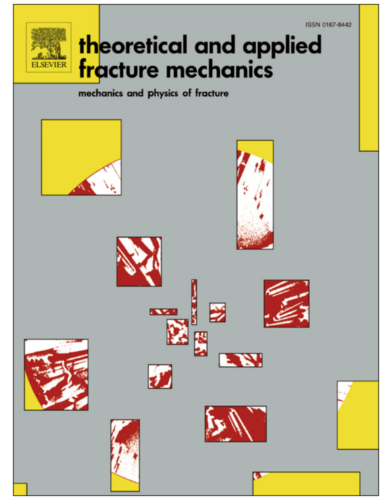

Effect of high graphite filler contents on the mechanical and tribological failure behavior of epoxy matrix composites

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Abstract

This work evaluates the effect of the presence of high graphite contents on the mechanical and tribological properties of epoxy matrix and carbon fiber reinforced epoxy matrix composites. Epoxy matrix composites containing 0 to 30 wt%-graphite were prepared by hand mixing. Graphite/epoxy fiber composites containing 0 to 11.5 wt%-graphite were also prepared. The produced materials were characterized regarding mechanical properties, including experimental and numerical analysis, and sliding wear resistance. Experimental results show that the addition of high graphite amounts results in materials with increasingly high elastic modulus. However it also results in increased brittle behavior, significantly reducing failure strain for additions above 12.5 wt%. Shear modulus and flexural shear modulus also increase with graphite addition. The presence of graphite in the epoxy matrix decreases subsurface fatigue wear and increases wear resistance, as a result of graphite lubricant action. Graphite/epoxy composites reinforced with carbon fiber present higher mechanical performance than conventional carbon fiber reinforced epoxy matrix composites. Attained results show that a maximum graphite concentration must be found to allow equilibrium between increased stiffness and wear resistance, and reduced fracture behavior. Nevertheless increasing graphite concentration above values commonly used in the literature appears to open an opportunity window for the processing of low cost hybrid materials combining high specific strength, increased conductivity and self-lubricant properties.

Keywords: Graphite platelets; epoxy resin; carbon fiber; mechanical properties; wear properties; composites

1. Introduction

There is increasing demand for advanced materials with improved properties, aiming to meet new requirements or to replace existing materials such as metal-based ones. This quest has significantly contributed to the advent of new polymer matrix composite materials that allowed major design improvements and found extensive application in the manufacture of a variety of products, including automobile and aircraft parts, structural components, sporting goods and biomedical devices. The high performance of continuous fiber reinforced polymer matrix composites is thoroughly known and documented. However these composites present disadvantages regarding the matrix-dominated properties, which often limit their applicability range [1]. The development of newer composite materials addressing these issues is thus of great significance for several engineering applications, broadening the range of potential structural applications of composites.

Fiber reinforced epoxy matrix composites are one of the most used multi-phase materials, mainly because of their exceptional strength-to-weight characteristics [2,3]. Epoxy-matrix composites present excellent mechanical and tribological properties, adequate chemical and corrosion resistance, and excellent dimensional stability [4]. However matrix stiffness, toughness and hardness, together with matrix-dominated properties such as in-plane and interlaminar shear, have room for further improvement [5]. A common approach for improving matrix properties consists on the incorporation of filler particles in the epoxy resin. Previous research by other authors showed that matrix-dominated mechanical properties of polymer