Tribo-investigations on bidirectionally reinforced PAEK composites with Zylon fabric

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High performance composites based on Poly aryl ether ketone (PAEK) (≈ 40 wt.%) reinforced with Zylon fabric (≈ 60 by wt.%) were developed by compression molding. Physical, thermal properties, and ILSS were evaluated. Tribo-performance was evaluated in abrasive and erosive wear modes. The performance was compared with neat PAEK to quantify the benefits endowed by the Zylon reinforcement and role of PEI as a sizing agent. Worn surface was analyzed using Scanning electron microscopy and Energy dispersive spectroscopy. Zylon fibres reduced the wear rate of PAEK in both the wear modes significantly and sizing of fibers by PEI proved beneficial.

Keywords: PAEK, Zylon, tribology, bi-directional composites

1. Introduction

Bi-directionally (BD) reinforced composites are favoured as they offer bidirectional strength giving a set of balanced mechanical and tribological properties[1]. Poly(p-phenylene-2,6-benzobisoxazole) (PBO), (commercially known as Zylon), fibres possess a unique set of performance properties such as excellent strength, modulus, resistance to creep and chemicals, very high thermal stability, flame retardance, etc.(Table 1)[2,3].In spite of this, as compared to the fibers of carbon, glass, Kevlar etc., PBO fibers remain underexplored for exploiting its properties to make composites with excellent combination of structural and tribological properties.

2. Methods

High performance polymer composites based on Poly aryl ether ketone (PAEK) (≈ 40 wt.%) reinforced with Zylon fabric (≈ 60 by wt.%) were developed by compression molding technique. Fabric plies were initially impregnated with 5% Polyetherimide solution (PEI) to enhance the wettability of polymer with fibers. Calculated number of PAEK films were alternately stacked using these prepregs. One more composite was developed without using PEI solution as sizing agent. Physical, thermal and thermo-physical, properties, apart from ILSS (interlaminar shear strength) were evaluated. Tribo-performance of the composites was evaluated in abrasive and erosive wear modes. The performance was compared with neat PAEK to quantify the benefits endowed by the Zylon reinforcement and role of PEI as a sizing agent. Worn surface analysis was done using Scanning electron microscopy and Energy dispersive X ray analysis to analyse the wear mechanisms.

Table 1: Comparative properties of various fibers

Properties	Glass fibers	Carbon fibers	Kevlar fibers	Zylon fibers
Density (g/cc)	2.54	1.76	1.44	1.54
Modulus (GPa)	72.5	231	131	180
Strength (MPa)	3450	3750	3600 - 4100	5800
CTE (F^{-1})	6.3 x 10^{-6}	-0.30 x 10^{-6}	-2.7 x 10^{-6}	-6 x 10^{-6}

2.1. Results

Zylon fibres effectively reduced the wear rate of PAEK in both the wear modes significantly at all loads and sizing of fibers by PEI proved beneficial since the performance of this composite was highest.

3. Discussion

PEI as a sizing agent on fibers effectively helped in wetting of cross-over points and interaction of the fibers and matrix. This in turn helped in effective load transfer and better wear properties. Zylon fabric, due to its exceptionally better strength and modulus, gave better tribo-performance in both abrasive and erosive wear modes as compared to neat PAEK.

4. References

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