FRACTURE BEHAVIOUR OF MULLITE FIBRE REINFORCED MULLITE MATRIX COMPOSITES UNDER QUASI-STATIC AND BALLISTIC IMPACT LOADING

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The development of oxide fibre-reinforced oxide matrix composites is a promising way of achieving lightweight, structural materials combining high-temperature strength with improved fracture toughness, damage tolerance, thermal shock and oxidation resistance [1]. Significant research effort has been devoted to the optimisation of these ceramic matrix composite systems, taking into account also the development of reliable and cost-effective fabrication procedures.

The material investigated in this work was a composite formed by a mullite matrix containing homogeneously distributed ultra-fine (70-350 nm) porosity reinforced with $NdPO_4$-coated mullite woven fibre mats (Nextel^{TM} 720). The details of the material fabrication, which was done by a combination of electrophoretic deposition, pressure filtration and pressureless sintering, have been published elsewhere [2].

The fracture behaviour and damage development in the composites has been investigated using chevron-notch technique and ballistic impact tests. Fracture toughness (K_{IC}) values in the range of 1.8 to 3.3 $MPam^{1/2}$ were determined using the chevron notched specimen technique. A large variability of K_{IC} data due to the

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complex (heterogeneous) composite microstructure was found. Extensive fibre pullout occurs in the composites during failure, as shown in Figure 1, which is due to a favourable matrix/fibre interfacial bond given by $NdPO_4$ coating of the fibres. The materials response under ballistic impact loads was studied using a gas gun. The projectiles were glass balls of 10.15 mm in diameter and weighing 1.4 g. The projectile velocity was in the range 77.6 m/s - 207.5 m/s. The remanent strength of composite samples after the ballistic test was measured to quantify ballistic impact induced damage. The composites retained some of their load bearing capacity even after penetration of the projectile, since structural damage caused by projectiles remains localized, preventing catastrophic failure. Penetration by the projectile occurs at impact energy of about 4 J for the conditions investigated. Understanding crack propagation and damage development under ballistic impact loads opens new opportunities for the use of these composites in lightweight armour applications.

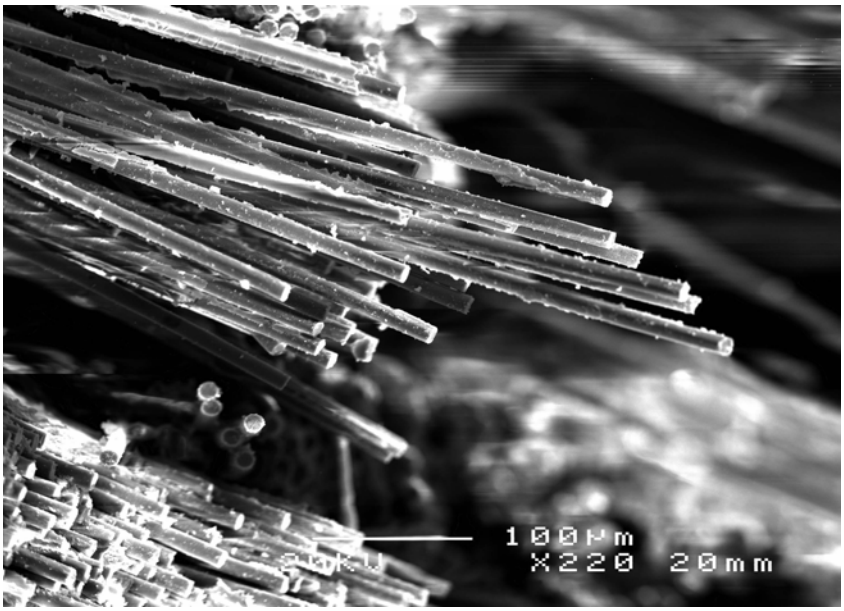

Figure 1. Fracture surface of a chevron-notched specimen showing extensive and uniform fibre pull-out.

References

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