MICRO-NANO SCALE CHARACTERIZATION OF THERMALLY TREATED SINGLE BASALT FIBRES

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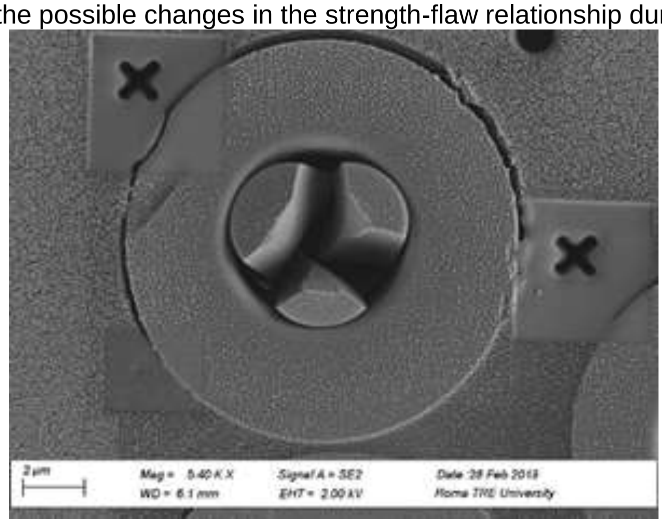
Thermoset matrix composites exhibit severe problems related to their environmentally unfriendly disposal and, therefore, there is a growing need to recycle the fibres and potentially reuse them in new products. The most common technique involves the removal of the polymer matrix at high temperature, but reclaimed fibres usually experience a severe loss in mechanical properties, which make them unsuitable for structural applications. This is the case for glass fibres and also for the more heat-resistant basalt fibres. The aim of the present work is to assess the evolution of mechanical and nano-mechanical properties of single basalt fibres, as a function of thermal exposure, from the microscale down to the nanoscale, with a view to highlighting the mechanisms responsible for the decrease in tensile strength with increasing temperature. As-received and thermally treated basalt fibres have been characterized in terms of Elastic modulus and tensile strength. In order to shed light on the possible changes in the strength-flaw relationship during heat treatment, the fracture toughness of single basalt fibres has been investigated by combining single edge notch tension and micro-pillar splitting [1] methods along with high-speed statistical nanoindentation mapping across fibre diameter [2]. The fracture process of as-received and thermally treated basalt fibres appears to be controlled by surface flaws irrespective of heat treatment temperature, but the bulk properties (Elastic modulus and K_{IC}) change during thermal recycling. With regard to glass fibres, several mechanisms have been proposed to explain the strength loss, which are classified as superficial (sizing removal and the diffusion of water) and structural phenomena. The results of this study highlight the presence of structural modifications occurring during heat treatments that can be correlated with the fracture toughness variations as a function of high temperature exposure. In particular, both Elastic modulus and K_{IC} were found to increase after thermal exposure, with the occurrence of a significant microstructural anisotropy mainly localized in the outer layer of the fibres.



Micro-pillar, fabricated out of the basalt fibre, after the splitting test.

References:
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