EVALUATION OF THE ENVIRONMENTAL DEGRADATION OF INTERPHASES IN CERAMIC MATRIX COMPOSITES (CMCs) VIA SEM IN-SITU MICROMECHANICAL TESTING

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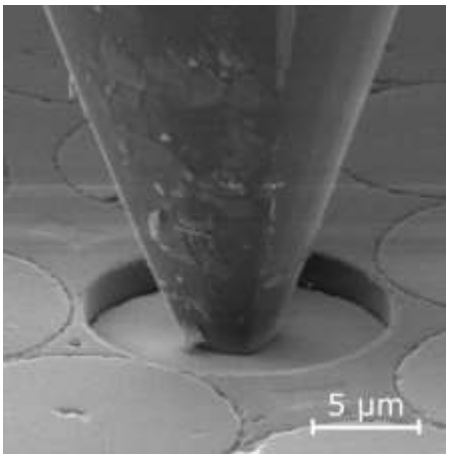
The need to increase the cycle efficiency and reduce NOx emissions from aero-engines has promoted the development of Silicon Carbide (SiC) based Ceramic Matrix Composites (CMCs) which have entered in service in aircraft turbine engines as replacements for some Ni-based superalloys. The main tendency of material choice is converging to CMCs constituted by SiC fibres coated with a thin (0.1-1 µm) BN interphase within a SiC matrix (SiC/BN/SiC), resulting in an optimised tough ceramic composite. However, unlike the generic tendencies found for metallic materials, environmental effects seem to not follow a clear tendency as hottest temperatures do not necessarily result in more severe degradation. This is due to the complex degradation thermodynamics occurring at the interface of the SiC-BN system such as volatilisation of B species, borosilicate glass formation or formation of self-healing oxide products.



The present study focuses on understanding how the interfacial and fibre properties in SiC/BN/SiC are affected by different aero-engine inspired degradation cycles by exploring the interfacial properties via push-out tests and the fibre properties via three point bending of single fibres. These tests are performed in-situ to achieve a higher repeatability in the testing conditions and allowing for characterization of the variability coming from the ceramic material itself. These mechanistic results are then complemented with TEM-based characterization techniques in order to link the change in properties to the changes in chemistry and microstructure.

The goal of this work is then to understand how the localised changes appearing mainly at these interphases affects the overall toughening behavior of SiC-based CMCs at the bulk scale.

Figure 1 – SEM in-situ push out test on a SiC/BN/SiC CMC