CHEMICAL AND MECHANICAL ANALYSIS OF HIGH TEMPERATURE SIC/SIC CMC MATERIALS

Michael Goode, University of Oxford, United Kingdom
michael.goode@lincoln.ox.ac.uk
David Armstrong, University of Oxford, United Kingdom

Key Words: SiC/SiC CMCs, High Temperature Degradation, Nanoindentation, Mechanical Characterisation

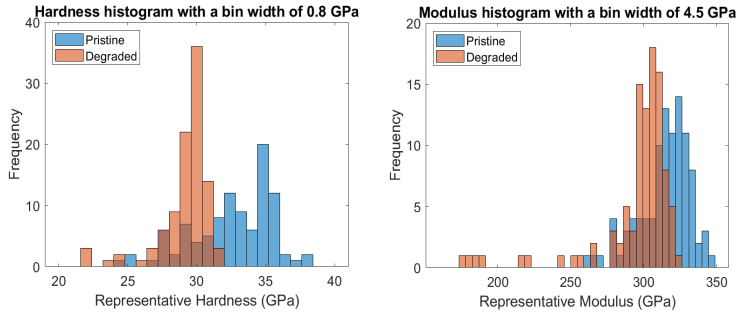

Figure 1 – Histograms of 1µm deep indents showing the effect of steam degradation on Hi-Nicalon Type S SiC Fibres

Ceramic Matrix Composites (CMCs) are seeing increased use in high temperature environments, especially within the Aerospace industry. Of particular interest is Silicon Carbide (SiC) composites with a BN interlayer, which provide the strength and stiffness required for use in Jet engine environments. However, both these materials are highly reactive with Oxygen and Water and have to be protected from the environment by Barrier Coatings to improve service life. CMC components in engines allow higher Turbine Entry Temperatures, which gives the engine a higher cycle efficiency as well a reduction in cooling requirements, improving thrust-to-weight ratio and lowering fuel consumption and exhaust emissions. This poster investigates mechanically characterizing both pristine and oxidised samples using traditional nanoindentation and nanoindentation mapping, alongside cross-correlated EDX, to allow representative hardness and modulus values to be obtained for each component of the microstructure.

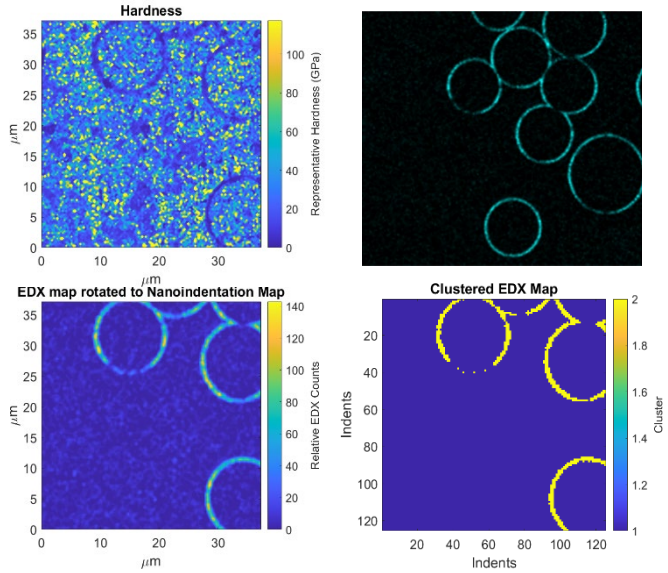

Figure 2 – Clockwise from top left: Nanoindentation Express Map of a SiC/BN/SiC sample with the BN clearly visible, EDX of the same area showing the Nitrogen signal, the EDX map correlated to the nanoindentation map, and the correlated data clustered according to composition giving the representative BN Hardness as 15.6GPa.

Nanoindentation mapping uses shallow indents placed closely together, with each indent giving a hardness and modulus value for each indenter position, allowing a map of the surface to be built up. This can then be correlated with EDX analysis, allowing the sample to be clustered by chemical composition, and the partitioned data can then be analysed to find the average hardness and modulus of each component phase. As the indents are so shallow here, the data gained from the indents is not an absolute value, but the relative differences between the hardness and modulus of different components of the microstructure are representative [5]. This technique is especially useful for SiC/BN/SiC CMCs, as the BN interlayer is often only hundreds of nanometres thick, which is too thin to be indented using traditional nanoindentation.

Using traditional nanoindentation alongside express mapping provides the necessary tools to examine the degradation of SiC/BN/SiC CMCs in simulated environments, which will prove useful in profiling and determining the kinetics of degradation of CMC Materials.