MECHANICAL CHARACTERISATION OF THE PROTECTIVE Al_2O_3 SCALE IN Cr_2AlC MAX PHASES

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MAX phases have great potential under demands of both high-temperature and high-stress performance, with their mixed atomic bonding producing the temperature and oxidation resistance of ceramics with the mechanical resilience of metals.

Here, we measure the mechanical properties up to 980˚C by nanoindentation on highly dense and pure Cr2AlC, as well as after oxidation with a burner rig at 1200˚C for more than 29 hours. Only modest reductions in both hardness and modulus up to 980˚C were observed, implying no change in deformation mechanism.

Furthermore, micro-cantilever fracture tests were carried out at the Cr_2AlC/Cr_7C_3 and Cr_7C_3/Al_2O_3 interfaces after the oxidation of the Cr_2AlC substrates with said burner rig. The values are typical of ceramic-ceramic interfaces, below 4 MPa√m, leading to the hypothesis that the excellent macroscopic behaviour is due to a combination of low internal strain due to the match in thermal expansion coefficient as well as the convoluted interface.

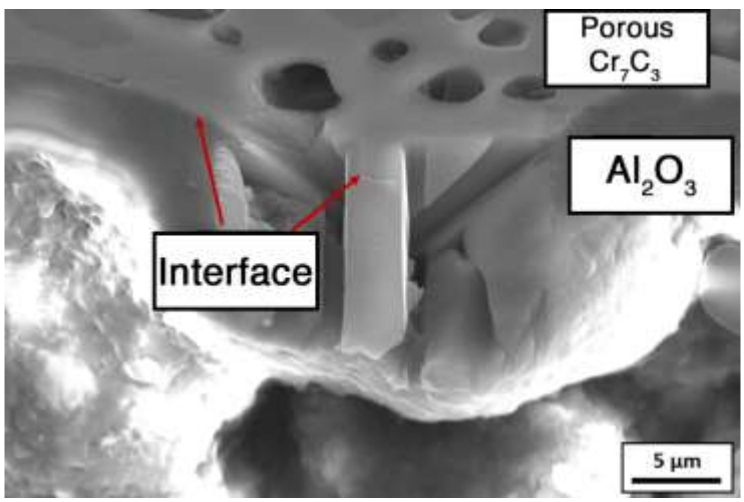

Figure 1: Typical micro-cantilever produced for fracture toughness tests, with a FIB-made pre-notch at the boundary of interest (here, the Cr7C3-Cr2AlC boundary near the base of the beam).