MEASUREMENT OF ENHANCED DUCTILITY IN NANOLAYERED CERAMICS VIA MICRO-COMPRESSION TESTING AND DIGITAL IMAGE CORRELATION

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The use of ceramic or intermetallic structures in industrial applications is limited by their brittleness. However, it has been shown that nanolayered ceramics, such as the MAX phases, show unusually high levels of plasticity, with resolved shear yield stresses being reported to be as low as 77 MPa [1]. Our aim is to show that the origin of this behaviour is related to electron density shifts between layers, which enable eased dislocation movement compared to non-layered ceramics [2]. For an accurate study of this effect, and to prove its generality, a reliable determination of the onset of plastic deformation in form of dislocation movement is crucial.

It is demonstrated how this can be achieved by a method that combines micropillar compression with strain mapping of the pillar [3]. For this purpose, compression of cuboidal micropillars is carried out, and strain mapping of the pillar is facilitated by digital image correlation (DIC) of a Pt speckle pattern that was applied on the pillar side surface. Here, results are presented for a Cr_2AlC MAX phase. It is shown that the method enables accurate tracing of slip bands within the pillar, which can be directly correlated to yield drops in the compressive stress-strain curve (Figure 1). This allows for enhanced interpretation of resolved shear yield stresses obtained as a result of micropillar compression, and thus enables a better evaluation of the onset of dislocation movement.

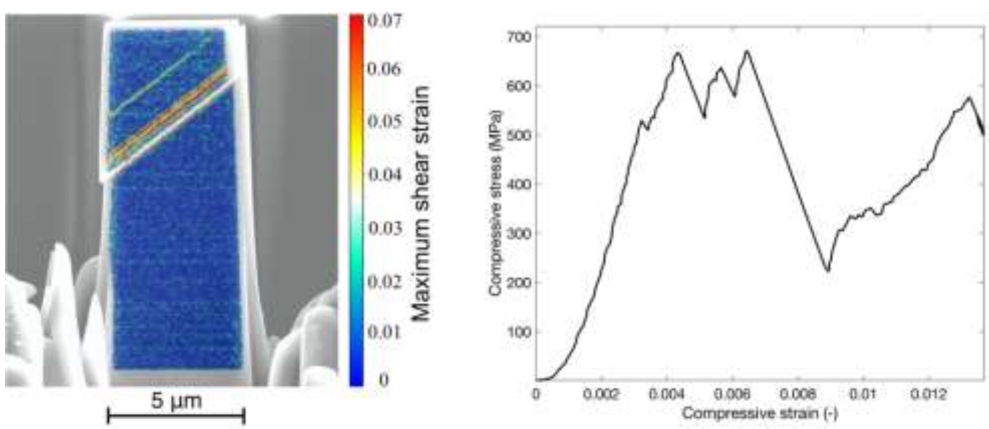

Figure 1 – Strain map of a Cr_2AlC micropillar and the corresponding stress-strain curve. The map shows four slip bands, which can be correlated to the four yield drops in the stress-strain curve.

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