HIGH STRAIN RATE TESTING OF ULTRA FINE GRAINED ALUMINIUM AT MICRO AND MACRO LENGTH SCALES

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Key Words: High strain rate testing, Micro vs macro comparison, ultrafine grained materials, activation volume, strain rate sensitivity

There are rapid advances in microscale testing enabling both nanoindentation and micropillar compression to be performed at high strain rates, exceeding 1 s^{-1}.[1][2] However, till date, there is no systematic comparison of the microscale test results with other established macroscale high strain rate methods, for e.g. Split Hopkinson Pressure Bar (SPHB) tests that can achieve > 1000 s^{-1} strain rates[3]. This poster will present a comparison study between micro- and macro-length scale testing using an ECAP ultra fine grained (UFG) aluminium sample. The experiments were performed in uniaxial compression using cylindrical geometries at macroscale (~16mm diameter and ~8mm thick) and microscale (micropillar ~10µm diameter and ~15 µm height). The average grain size of the UFG aluminium is around 1-2 µm, which includes a significant number of grains even in microscale testing (a micropillar contains >500 grains). Due to small grain size and interrogating large number of grains, no size effects are expected and the yield strength can be assumed to be controlled by the grain size predominantly. Microscale testing was performed from 10^{-3} s^{-1} to 750 s^{-1} and macro scale tests from 10^{-2} s^{-1} to 10^{3} s^{-1}. Additionally, strain rate jump tests were performed at both length scales to obtain strain rate sensitivity (SRS) exponent and activation volumes for deformation. The SRS exponents obtained in both cases were found to be in excellent agreement. The activation volumes obtained from both the scales lie in the range of 90-150 b^3 indicating similar dominant deformation mechanisms. No change in deformation mechanisms were observed from 10^{-2} s^{-1} to 10^{3} s^{-1} strain rates. This study provides confidence on the reliability of microscale high strain rate test techniques and paves the way for routine tests at high strain rates.

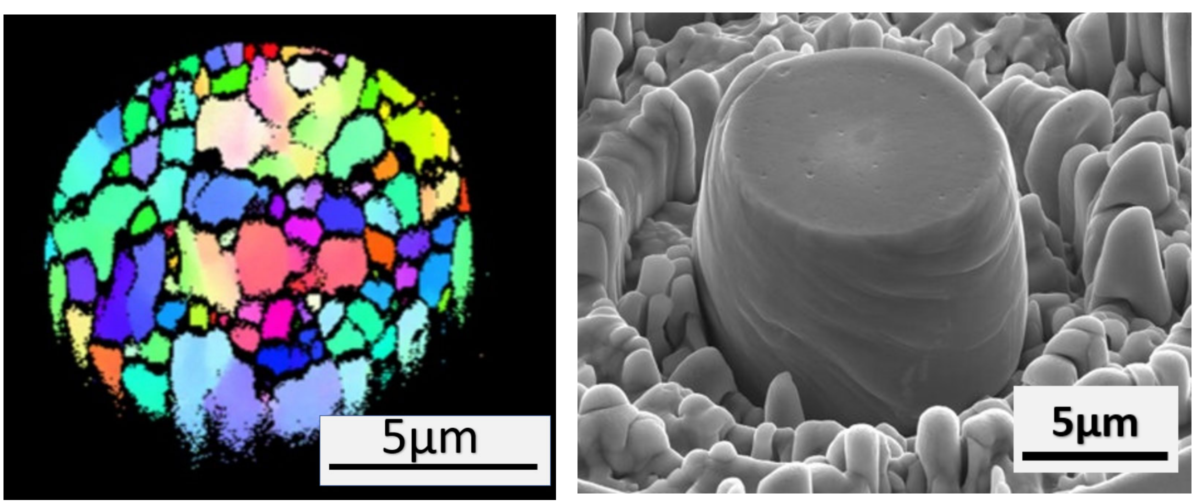

Fig1 a) Microstructure of the top surface of ufg al pillar using EBSD b) Micropillar post compression at 750/s strain rate.

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