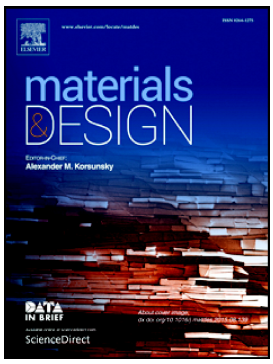

Essential refinements of spherical nanoindentation protocols for the reliable determination of mechanical flow curves

A. Leitner, V. Maier-Kiener, D. Kiener

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Essential refinements of spherical nanoindentation protocols for the reliable determination of mechanical flow curves

A. Leitner [a], V. Maier-Kiener [b], D. Kiener [a*]

a Department Materials Physics, Montanuniversität Leoben, Jahnstraße 12, A-8700 Leoben, Austria

b Department Physical Metallurgy and Materials Testing, Montanuniversität Leoben, Roseggerstraße 12, A-8700 Leoben, Austria

E-Mail:

Alexander Leitner alexander.leitner@unileoben.ac.at

Verena Maier-Kiener verena.maier-kiener@unileoben.ac.at

Daniel Kiener daniel.kiener@unileoben.ac.at

* Corresponding author: Daniel Kiener, Department Materials Physics, Montanuniversität Leoben, Jahnstraße 12, A-8700 Leoben, Austria, E-mail: daniel.kiener@unileoben.ac.at

Abstract. Understanding and linking mechanical properties obtained by spherical indentation experiments to uniaxial data is extremely challenging. Since the first attempts in the early 20th century numerous advances gradually allowed to expand the output of indentation tests. Still, the extraction of flow curves from spherical nanoindentation has not yet been fully established, as tip shape problems and size effects impede a straight-forward implementation. Within this study, we show new calibration procedures originating from fundamental geometrical considerations to account for tip shape imperfections. This sets the base for strain-rate controlled tests, which in turn enables us to measure rate-dependent material properties either with constant strain-rate or by strain-rate jump tests. Finally, experimental evaluation of the constraint factor in consideration of the mechanical properties and induced strain enables the extraction of flow curves. Testing materials with refined microstructures ensures the absence of possible size-effects. This study contributes to a significant improvement of current experimental protocols and allows to move flow curve measurements from single spherical imprints one step closer to its implementation as a standard characterization technique for modern materials.

Keywords: Spherical nanoindentation, tip calibration, constant strain-rate tests, strain-rate jump tests, nanoindentation flow curves