SPHERICAL NANOINDENTATION – ADVANCEMENTS AND PROSPECTS TOWARDS ITS APPLICATION AS A MULTIFUNCTIONAL TESTING TECHNIQUE

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With the development of modern high-performance materials and components, cases increase where conventional testing techniques used for the mechanical characterization miss their target. Material fabrication at a bench scale, miniaturization and not least cost-effectiveness yearn for a highly reliable, fast and highly automatable testing technique. Even though uniaxial micromechanical tests on micro-pillars or -tensile samples are well suitable for the extraction of flow curves, they face the problem of elaborate specimen manufacturing. Spherical nanoindentation could be a candidate technique to overcome the mentioned drawbacks, since time needed for sample preparation is tremendously reduced. The present study will outline solutions of existing problems, which may lay the foundation for spherical nanoindentation to become a widely-used testing technique. Main objections concerning tip imperfections will be resolved by modifying the calibration procedure, and validated on a broad spectrum of materials independent of the indenter tip radius. Once the actual tip shape is available, displacement-time profiles can be designed to guarantee constant strain-rates during testing and thus permit the determination of the strain-rate sensitivity for rate-dependent materials. Finally, the comparison between nanoindentation flow curves and uniaxial tests will evidence that spherical indentation is a highly reliable technique for the extensive mechanical characterization of modern high-performance materials and show its high potential as a multifunctional standard testing technique.

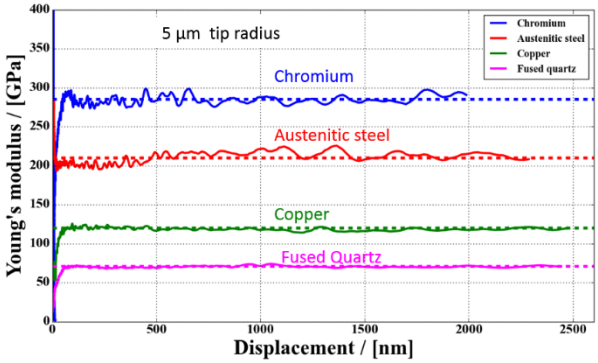

Figure 1 – Young's modulus profiles determined with an imperfect 5 µm radius tip validate new tip calibration approach

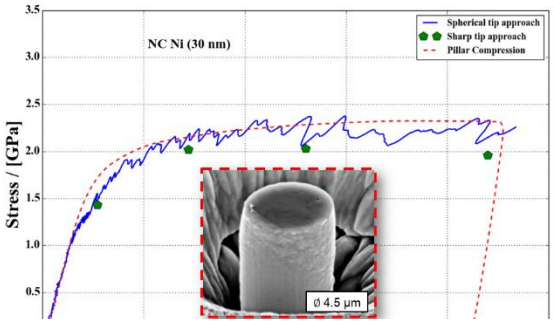

Figure 2 - Comparison of flow curves obtained from nanoindentation and micro-compression tests