Advanced Nanomechanical Testing for Accelerated Material Development

Verena Maier-Kiener[1]

[1] Montanuniversität Leoben, Department Materials Science, Roseggerstr. 12, A-8700 Leoben, verena.maier-kiener@unileoben.ac.at, materials.unileoben.ac.at

Key Words: *Nano- and Micromechanical Testing, Advanced Testing Methods, High Performance Materials, High-Throughput Testing, MecaNano.*

Abstract

In recent years, micromechanical testing techniques based or derived from nanoindentation experiments became a versatile tool for testing local mechanical properties, providing access to properties way beyond hardness and modulus. While standard methods can be easily used for conventional mechanical properties analyses, also a high throughput screening of various materials conveniently achievable [1]. Moreover, smart adjustments of standard nanoindentation protocols open an even wider range of applications. For example, it was possible to directly probe dominating thermally activated deformation processes in materials by applying abrupt strain-rate changes within the indentation process [2]. In addition to these advanced testing methods, setups can be modified in order to probe in-operando materials deformation behavior under ambient, but more importantly under non-ambient conditions, such as temperature ranges from -150 °C to ~ 1000 °C and under electrochemical conditions [3,4]. Especially the latter allows studying hydrogen materials-interactions and hydrogen embrittlement.

This talk will focus on the wide range of possibilities to investigate by micro- and nanomechanical testing methods and their correlation and implementations with respect to computer driven models, as well as to the newly started COST action 21121 MecaNano (European Network for the Mechanics of Matter at the Nano-Scale), which aims to bring together different research areas of micro- and nanomechanical testing, nanomechanical simulations as well as data driven machine learning approaches.

References

[1] V. Maier-Kiener, B. Schuh, E. George, H. Clemens, A. Hohenwarter: „Nanoindentation testing as a powerful screening tool for assessing phase stability of nanocrystalline high-entropy alloys", Materials & Design 115 (2017), 479-485. DOI: 10.1016/j.matdes.2016.11.055

[2] V. Maier-Kiener, K. Durst: "Advanced nanoindentation testing for studying strain-rate sensitivity and activation volume", JOM 69 (2017), 2246-2255. DOI: 10.1007/s11837-017-2536-y.

[3] J. Kappacher, A. Leitner, D. Kiener, H. Clemens, V. Maier-Kiener: "Thermally activated deformation mechanisms and solid solution softening in W-Re alloys investigated via high temperature nanoindentation" Materials & Design 189 (2020), 108499. DOI: 10.1016/j.matdes.2020.108499.

[4] A.S. Ebner, S. Brinckmann, E. Plesiutschnig, H. Clemens, R. Pippan, V. Maier-Kiener: "A Modified Electrochemical Nanoindentation Setup for Probing Hydrogen-Materials Interaction Demonstrated on a Nickel-Base Alloy" JOM 72 (2020), 2020-2029. DOI: 10.1007/s11837-020-04104-9.