SMALL-SCALE INSIGHTS INTO SUPERPLASTICITY USING MICROMECHANICAL TESTING METHODS

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In this work, the superplastic deformation behavior was investigated at the microscale as a function of temperature, strain-rate and grain-size. In detail, the superplastic alloy Zn22Al was characterized by nanoindentation at elevated temperatures, pillar compression experiments and in-situ micro tensile testing. Nanoindentation strain-rate jump tests show that the resulting strain-rate sensitivity is significantly affected by the applied strain-rate and testing temperature. The combination of these findings with the corresponding apparent activation energies evidences three different rate-controlling deformation processes, which are correlated with microstructural investigations of the residual imprints. However, significant differences regarding the deformation kinetics are observed when the size of the plastic zone is successively reduced and finally gets in the order of a few grains, giving rise to a minimum size of the plastic zone for superplastic material behavior. Via a combination of pillar compression experiments and EBSD analysis it is further suggested that superplasticity is the manifestation of a complex interaction between inter- and intra crystalline deformation processes. This behavior is discussed in detail, by taking the influence of the local phase characteristics and pillar dimension into account.

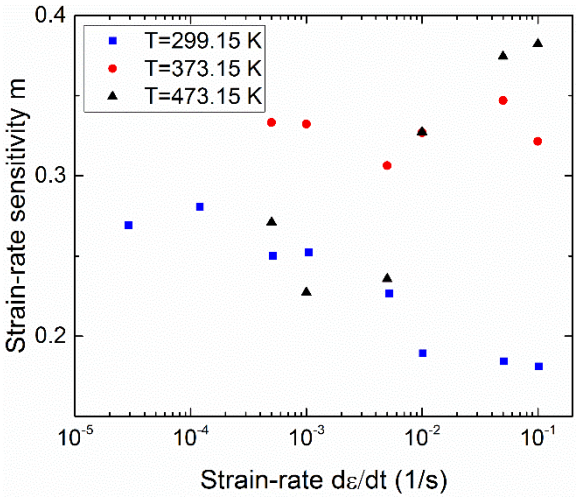

Figure 1 – Influence of the strain-rate and testing temperature on the nanoindentation strain-rate sensitivity for the superplastic alloy Zn22Al.