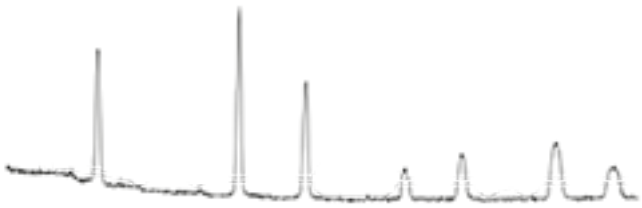

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Investigation in the onset of plasticity in high strength metal sheets used in automobile industry

Friday, 3 June 2022 09:00 (20 minutes)

In view of efficiency and resource scarcity, lightweight construction is an important issue for automotive industry. Here, the use of high- and ultra-high-strength steels offer enormous weight reducing potential in car body construction. However, a manufacturing disadvantage of these materials is the strong elastic springback due to the high yield strength and the associated difficulties with regard to dimensional accuracy. Numerical prediction of springback in formed metal sheets is still a challenge nowadays. Especially in high strength steel sheet metals, the modelling of elastic behaviour is crucial in cases where the non-linearity and decrease of Young's modulus cannot be neglected during sheet forming.
In the current study a temperature-dependent evaluation method (TDEM) [1] is investigated and further improved. Matching the thermo-elastic effect with the microscopic material behaviour shows that the temperature minimum can be considered as the onset of yielding, i.e. the maximum yield stress at zero plastic strain (YS0). The assumption is that the temperature minimum is the equilibrium between elastic cooling and plastic heating induced by deformation. To verify this hypothesis, lattice strains for mild steels as well as for high strength steels are measured in-situ using synchrotron radiation, while monitoring the temperature changes in the respective samples. The suitability and validity of the thermo-elastic effect for material characterization and the determination of the onset of yielding has been proven by following and comparing the evolution of the measured lattice strains and the dislocation density during loading and unloading. The results clearly indicate that the thermo-elastic effect yields suitable values for the correct determination of the onset of yielding in sheet metals, which is an essential parameter for predicting springback in current material models.

[1] S. Vitzthum, C. Hartmann, M. Eder, W. Volk, Temperature-based determination of the onset of yielding using a new clip-on device for tensile tests, Procedia Manufacturing 29 (2019) 490-497.

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