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BOOK OF ABSTRACTS

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Field Analysis of Energy Conversion During Plastic Deformation Process

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The paper presents field analysis of energy conversion process during uniaxial tension of the 310S austenitic steel. A new experimental approach which enables to determine energy balance components is proposed. The distribution of plastic work was determined based on the displacement field obtained using digital image correlation (DIC) technique and the previously developed DIC-based stress determination method [1]. In the present study, the constitutive model has been extended of the influence of strain rate and plastic anisotropy. The plastic anisotropy is described by the yield function introduced by Barlat and Liam [2]. On the other hand, the method of obtaining distribution of energy dissipated as heat combines temperature field measurements, coupled DIC and infrared thermography (IRT) analysis and also transient heat conduction equation [3]. The field analysis of the contributions of all the terms in the equation is performed with respect to the various process durations. The approach takes into account the thermoelastic effect and the heat exchange with the surroundings due to the heat convection and radiation. As a measure of the energy conversion the energy storage rate Z (defined as the ratio of the stored energy increment to the plastic work increment) was used. Just before the end of the process the Z value decreases significantly and becomes close to 0 or even negative, which means that the material loses its ability to store the energy. The microstructure investigation based on the electron backscatter diffraction (EBSD) analysis for subsequent stages of the process showed that material's microstructure evolves towards two dominant texture components.

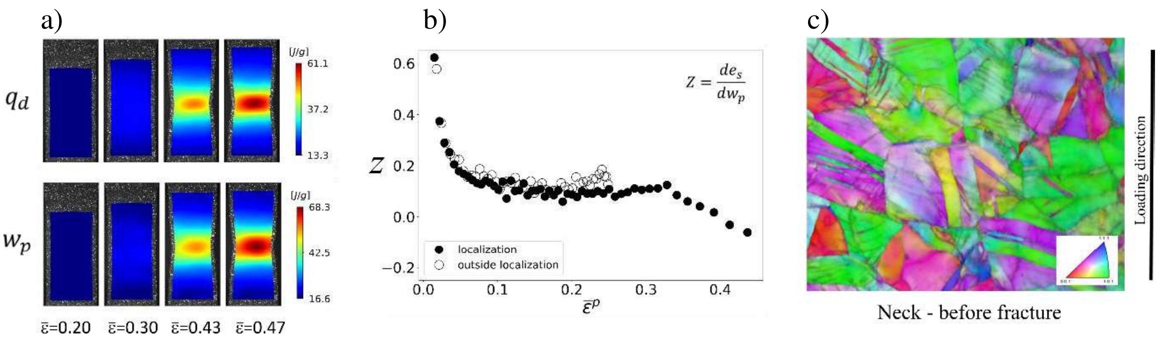

Figure 1: The evolutions of the q_d and w_p a), the energy storage rate b) and corresponding orientation map in necking area c).

References

[1] Musiał, S., Nowak, M., Maj, M., *Arch. Civ. Mech. Eng.* 19(4), 1183–1193 (2019).
[2] Barlat, F., Lian, K., *Int. J. Plast.* 5(1), 51–66 (1989).
[3] Musiał, S., Maj, M., Urbański, L., Nowak, M., *Int. J. Solids Struct.* 238, 111411 (2022).