A Multi-Mechanism Model for Cutting Simulations based on the Concept of generalized Stresses

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ABSTRACT

Based on the concept of generalized stresses as proposed by GURTIN [1] and FOREST [2], we extend an existing model for strain rate- and temperature-dependent asymmetric plastic material behaviour accompanied by phase transformation with a gradient term of phase fraction. To this end a chemical variable, representing the austenite volume fraction, is treated as an extra degree of freedom, and the influence of its first gradient will be studied. A generalized principle of virtual power is postulated involving generalized stresses and used to derive the constitutive equations. The bulk model is formulated within a thermodynamic framework. For the scenario of a cutting process we have a martensite-austenite-martensite transformation. For the asymmetric visco-plastic part we use a modified strain rate form (Huh-Kang form) with a quadratic dependence of strength on the logarithm of the strain rate as a replacement for the linear dependence of the Johnson-Cook model. Furthermore, two numerical examples are given. Firstly, we identify the material parameters for the material DIN 100Cr6 in a hardened state by using experimental data under tension, compression and torsion taking the SD-effect into account. Secondly, a cutting simulation is investigated to test our model and the different mechanisms are illustrated.

REFERENCES

[1] Gurtin, M. E.: Generalized Ginzburg-Landau and Cahn-Hilliard equations based on a micro force balance. Physica D 92 (1996) 3 - 4, S. 178 - 192.

[2] Forest, S.; Ammar, K.; Appolaire, B.: Micromorphic vs. phase-field approaches for gradient viscoplasticity and phase transformations. Lecture Notes in Applied and Computational Mechanics 59 (2011), S. 69 - 88.