



Science Arts & Métiers (SAM)

is an open access repository that collects the work of Arts et Métiers Institute of Technology researchers and makes it freely available over the web where possible.

This is an author-deposited version published in: <https://sam.ensam.eu>
Handle ID: <http://hdl.handle.net/10985/10442>

To cite this version :

Komi SOHO, Xavier LEMOINE, Hamid ZAHROUNI, Farid ABED-MERAÏM - Influence of the loading path on the mechanical behavior of metallic materials - 2014

Any correspondence concerning this service should be sent to the repository

Administrator : scienceouverte@ensam.eu





Science Arts & Métiers (SAM)

is an open access repository that collects the work of Arts et Métiers ParisTech researchers and makes it freely available over the web where possible.

This is an author-deposited version published in: <http://sam.ensam.eu>
Handle ID: <http://hdl.handle.net/null>

To cite this version :

Komi SOHO, Xavier LEMOINE, Farid ABED-MERAIM, Hamid ZAHROUNI - Influence of the loading path on the mechanical behavior of metallic materials - 2014

Any correspondence concerning this service should be sent to the repository

Administrator : archiveouverte@ensam.eu

INFLUENCE OF THE LOADING PATH ON THE MECHANICAL BEHAVIOR OF METALLIC MATERIALS

Komi Soho ^{a,c*} Xavier Lemoine ^{a,b} Farid Abed-Meraim ^{a,b,c} Hamid
Zahrouni ^{a,c}

^a Laboratoire d'Étude des Microstructures et de Mécanique des Matériaux (LEM3), UMR CNRS 7239, Ile du Saulcy F-57045, Metz Cedex 01 – France

^b Arts et Métiers ParisTech, 4 rue Augustin Fresnel, 57078 Metz Cedex 3 – France

^c Laboratory of Excellence on Design of Alloy Metals for low-mAss Structures (Labex DAMAS), Université de Lorraine – France

*corresponding author

Keywords: Crystal plasticity, self-consistent scheme, finite elements, elasto-plasticity.

Abstract

Commercial finite element software packages are widely used for the numerical simulation of sheet metal forming processes. However, most of existing software packages present some limitations. In particular, they are essentially based on phenomenological constitutive models and, accordingly, they do not precisely account for physical mechanisms of plasticity that take place at finer scales, or the associated microstructure evolution. In this context, we propose to couple the Abaqus finite element code (see [1, 2, 3, 4]) and the LAM3 code with micromechanical simulation techniques based on crystal plasticity and a self-consistent scale-transition scheme ([5, 6, 7]), as schematized in figure 1.

This coupling strategy will be applied to the simulation of rolling processes in order to assess the influence of the loading path on the evolution of the mechanical

properties of the material. By following some appropriately selected strain paths (see Figure 2) along the rolling process, one can predict the texture evolution of

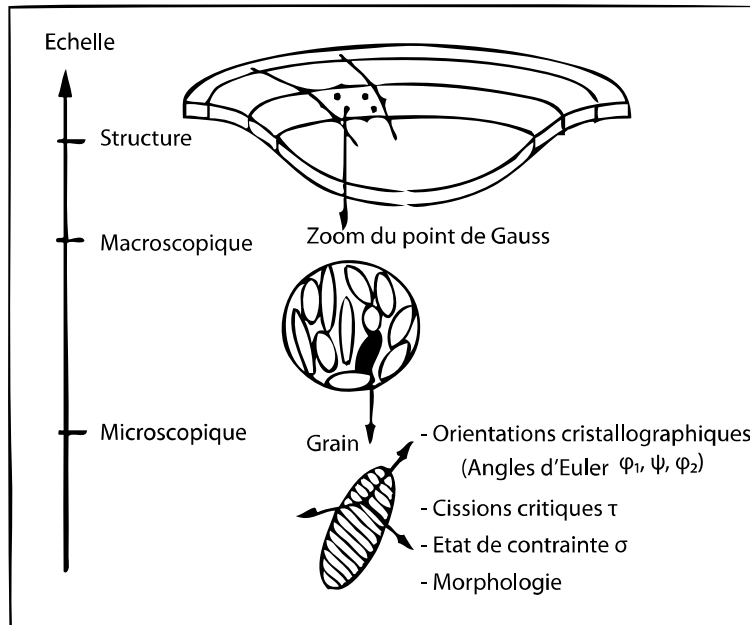


Figure 1: Schematic diagram of direct coupling strategy applied to the polycrystalline plasticity model by Scacciatella [8].

the material as well as other parameters related to its microstructure. Our numerical results are compared with experimental data in the case of ferritic steels elaborated by the steel maker ArcelorMittal.

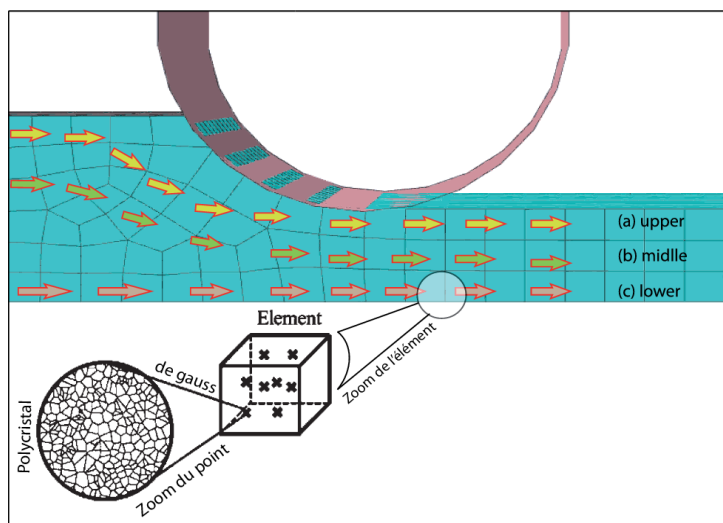


Figure 2: Schematic of the rolling simulation following the (a) upper, (b) middle, and (c) lower deformation path during the rolling process.

Bibliography

- [1] J. Segurado, R. A. Lebensohn, J. Llorca, and C. N. Tomé, "Multiscale modeling of plasticity based on embedding the viscoplastic self-consistent formulation in implicit finite elements," *Int. J. Plast.*, vol. 28, no. 1, pp. 124–140, 2012.
- [2] S. R. Kalidindi and L. Anand, "An approximate procedure for predicting the evolution of crystallographic texture in bulk deformation processing of fcc metals," *Int. J. Mech. Sci.*, vol. 34, no. 4, pp. 309–329, 1992.
- [3] K.-H. Jung, D.-K. Kim, Y.-T. Im, and Y.-S. Lee, "Prediction of the effects of hardening and texture heterogeneities by finite element analysis based on the Taylor model," *Int. J. Plast.*, vol. 42, pp. 120–140, 2013.
- [4] H. Zhang, X. Dong, Q. Wang, and Z. Zeng, "An effective semi-implicit integration scheme for rate dependent crystal plasticity using explicit finite element codes," *Comput. Mater. Sci.*, vol. 54, pp. 208–218, 2012.
- [5] P. Lipinski and M. Berveiller, "Elastoplasticity of micro-inhomogeneous metals at large strains," *Int. J. Plast.*, vol. 5, no. 1, pp. 149–172, 1989.
- [6] G. Franz, F. Abed-Meraim, J.-P. Lorrain, T. Ben Zineb, X. Lemoine, and M. Berveiller, "Ellipticity loss analysis for tangent moduli deduced from a large strain elastic–plastic self-consistent model," *Int. J. Plast.*, vol. 25, no. 2, pp. 205–238, 2009.
- [7] G. Franz, F. Abed-meraim, and M. Berveiller, "Strain localization analysis for single crystals and polycrystals: Towards microstructure-ductility linkage," *Int. J. Plast.*, vol. 48, pp. 1–33, 2013.
- [8] E. Scacciatella, "Intégration d'un modèle de comportement élastoplastique à transition d'échelle dans un code de calcul de structures par éléments finis," Ph.D. Thesis, Université de Metz, 1994.