

Research Topic for the Arts et Métiers ParisTech - CSC PhD Program

Subfield: Mechanical Engineering

ParisTech School: Arts et Métiers ParisTech

Title: Numerical study of miniaturization effects on the formability of metal sheets.

Advisor(s):

- Farid ABED-MERAİM (Full professor): farid.abed-meraim@ensam.eu
- Mohamed JEBAHI (Associate professor): mohamed.jebahi@ensam.eu

Short description of possible research topics for a PhD:

Due to the increasing trend towards miniaturization, ultra-thin metal sheets have become widely used in high technology fields, such as microelectronics and microbotics. However, when the thickness of a sheet decreases, some parameters, such as grain size and number of shallow grains, remain unchanged. This may result in modifying the mechanical properties, and thus the ductility limit, of the considered sheet. As a consequence, knowledge and understanding of conventional sheet behavior are no longer applicable for ultra-thin sheets. Further research effort is then needed to meet the emerging scientific challenges posed by the technological progress towards miniaturization. Within this context, the present PhD thesis aims to study the influence of the ratio between sheet thickness and grain size on the formability of ultra-thin metal sheets, using numerical approaches (e.g. Finite Element Method, Fast Fourier Transform based method, etc.). First, these size effects on the sheet behavior will be investigated in order to develop a robust constitutive model for ultra-thin sheets, which accounts for these effects. Then, this model will be coupled with plastic instability criteria (e.g. bifurcation approach, linear perturbation analysis, etc.) to study the influence of size effects on the ductility limit of the considered (ultra-thin) sheets.

Required background of the student:

Computational mechanics, Material behavior, Sheet metal forming processes

A list of 5 (max.) representative publications of the group:

- [1] Bouktir, Y. and Chalal, H. and Haddad, M. and Abed-Meraim, F., *Investigation of ductility limits based on bifurcation theory coupled with continuum damage mechanics*, Materials & Design 90 (2016), pp. 969-978.
- [2] Ben Bettaieb, M. and Abed-Meraim, F., *Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses*, International Journal of Plasticity 65 (2015), pp. 168-190.
- [3] Akpama, H. K. and Ben Bettaieb, M. and Abed-Meraim, F., *A comparative study of Forming Limit Diagrams predicted by two different plasticity theories involving vertex effects*, Key Engineering Materials 651-653 (2015), pp. 21-26.
- [4] Mansouri, L. Z. and Chalal, H. and Abed-Meraim, F., *Ductility limit prediction using a GTN damage model coupled with localization bifurcation analysis*, Mechanics of Materials 76 (2014), pp. 64-92.
- [5] Abed-Meraim, F. and Peerlings, R. H. J. and Geers, M. G. D., *Bifurcation analysis versus maximum force criteria in formability limit assessment of stretched metal sheets*, International Journal of Applied Mechanics 6 (2014), pp. 1450064.

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:
ali.siadat@ensam.eu AND yvon.velot@ensam.eu