Post-doctoral position at LGCGM (INSA-Rennes) and IRDL (UBS-Lorient)

Characterization and modeling of Ti alloys under complex loadings: application to incremental forming

Context

In many industrial fields, stamping is a widespread process for the forming of metal sheets. This process is well adapted for the manufacture of parts in large runs but very expensive for small production runs and prototyping. To improve the manufacturer productivity and competitiveness, new flexible and inexpensive processes must be developed to meet all the client needs. Incremental sheet forming is an emerging process with a strong potential to form industrial parts without specific tools. During the process, the sheet metal blank is clamped and a small-size smooth-end hemispherical tool moves along a user-specified path to deform the sheet incrementally. The virtual prototyping of the process is an essential step for the selection and optimization of process parameters. One of the difficulties in the simulation of the process is the modelling of the mechanical behaviour of materials. The characterization of elastoplastic behaviour (hardening under large deformations, anisotropic yield criterion) and forming limits (necking and fracture) must be adapted to the complex strain paths measured during incremental forming process. The identification of material parameters needs dedicated experimental devices and procedures in order to reproduce the specific forming conditions of the process.

Objectives and work program

This study is dedicated to the characterization and modelling of the mechanical behavior of a titanium alloy under complex strain paths representative of incremental forming. A combined experimental and numerical approach is to be developed. A commercial alloy in sheet form is considered.

The first part of the study is a numerical investigation of strain paths in incremental forming, based both on a bibliographic analysis and finite element simulation of a specific geometry [1]. Indeed, these results are expected to highlight the strain history of material points during forming. Complex strain paths may involve a continuous change of the direction of the strain path, and/or partial unloading and reloading in a different direction.

Then, in a second step, characterization of the mechanical behavior should be carried out using the facilities of the two laboratories. In particular, cross biaxial test [2,3], simple shear test and hydraulic bulging [4] may be of interest. The mechanical behavior of Ti alloys has been widely investigated under monotonic strain paths, however, much less under complex strain paths which is the originality and strength of this study. Anisotropy and hardening would be the focus of this investigation, as well as rupture.

In a third step, validation of the numerical simulation of the incremental forming of a truncated conical geometry is planned. Experimental results should be obtained for the Ti alloy and numerical predictions are compared with experimental values, e.g. the final geometry and applied load.

The post-doctorate will be located mainly at LGCGM, in Rennes, with some travels and short stays at IRDL, in Lorient.

[1] J.Belchior, L.Léotoing, D.Guines, E.Courteille, P.Maurine, A Process/Machine coupling approach: Application to Robotized Incremental Sheet Forming, Journal of Materials Processing Technology, 214 (2014) 1605-1616
[2] S. Zhang, L. Léotoing, D. Guines, S. Thuillier, S. Zang, Calibration of anisotropic yield criterion with conventional tests or biaxial test, International Journal of Mechanical Sciences 85 (2014) 142-151
[3] S. Zhang, L. Léotoing, D. Guines, S. Thuillier, Potential of the cross biaxial test for anisotropy characterization based on heterogeneous strain field, Experimental Mechanics (2015) DOI 10.1007/s11340-014-9983-y
[4] N. Souto, A. G. Andrade-Campos, S. Thuillier, Material parameter identification within an integrated methodology considering anisotropy, hardening and rupture, Journal of Materials Processing Technology 220 (2015) 157–172

Expected backgrounds

A strong background in the modelling and identification of mechanical behaviour of metal sheets is expected. Applicants with a large experience in experimental mechanics and numerical simulation of forming processes will be considered with attention.

Conditions

- Applicants must have spent one year abroad (away from France) during the last three years.
- Duration: 18 months
- Starting date: between March and May 2018
- Salary: 1950 € net (after tax removal) per month

Contacts

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How to apply: send CV and motivation letter by email to L. LEOTOING.