

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

**Subfield:** New Forming Process and Processus Eng., material Eng, power and energy cost.

**ParisTech School:** LCFC METZ

**Title:** Power and energy investigation necessary for thixoforging

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### **Short description of possible research topics for a PhD: (**

Thixoforging is a manufacturing process of metal alloys at semi-solid state. Semi-solid state is obtained by heating the material from the solid state, up to a temperature within the solidus-liquidus temperature range. Since always, Industry minimizes manufacturing process plan and increases mechanical behaviour. In this topic, the thixoforging process offers important perspectives especially steel thixoforging. It is on the way of industrial development between casting and forging process thanks the typical rheological behavior of the semi-solid material. For thixoforging, the liquid fraction is quite low, less than 20% and it is generally obtained by heating from raw material with a inductive furnace.

The proposed subject is dedicated to the investigation of energy and power requirement for thixoforging of complex parts for the industry. Currently, there is no study estimated the energetical cost or financial of production of a complex part obtained by thixoforging or a comparison with costs of the same part made with other processes. Different kinds of materials from industry, different billet heating systems, thixoforging and conventional forging, parts with mechanical and microstructure properties, the evaluation standards, etc, will be investigated. The objective is to give detailed information concerning thixoforging and conventional forging from energy and power point of view. This work must give and improve evaluation tools to choose or not the thixoforging to make a complex part, compare at other processes.

**Required background of the student:** (Which should be the main field of study of the applicant before applying) The student must have a background in forming process, steel and aluminum material (and in preference in semi-solid state), eng. Software Catia® and Forge®. He need have a good approach with experimental studies.

- Gu, G. C., Pesci, R., Becker, E., Langlois, L., & Bigot, R. (2014). In Situ Microstructure Observation of Steel Grades in the Semi-Solid State for Thixoforging Process by Using Confocal Laser Scanning Microscopy. *Solid State Phenomena*, 217-218, 15–22. doi:10.4028/www.scientific.net/SSP.217-218.15. ISBN: 978-303835220-4.
- [Favier, V., Becker, E., & Bigot, R. (2014). Investigation of Parameters Promoting Hot Cracking during Semi-Solid Forming Processes. *Solid State Phenomena*, 217-218, 281–285. doi:10.4028/www.scientific.net/SSP.217-218.281.
- Bigot, R., Becker, E., & Langlois, L. (2013). Some approaches on industrialization of steel thixoforging processes. *Solid State Phenomena*, 192-193, 521-526, ISBN: 978-303785481-5.
- Neag, A., Favier, Véronique, Pop, M., Becker, E., Bigot, R, 2012. Effect of experimental conditions on 7075 aluminium response during thixoeextrusion. *Key Engineering Materials* 504-506, 345–350. ISBN: 978-303785366-5.
- Becker, E., Favier, V., Bigot, R., Cezard, P., & Langlois, L. (2010). Impact of experimental conditions on material response during forming of steel in semi-solid state. *Journal of Materials Processing Technology*, 210(11), 1482–1492. doi:10.1016/j.jmatprotec.2010.04.006

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