Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Materials engineering, metallurgy, mechanical engineering

Title:Architectured metallic sheets through localized laser processing

ParisTech School: Arts et Métiers, Paris campus

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Short description of possible research topics for a PhD: Architectured materials are an emerging class of advanced materials that bring new possibilities in terms of functional properties, filling gaps in material performance maps. Localized processing methods appear as natural candidates for developing such materials.In the context of the SCOLASTIC project aiming at developing architectured metallic materials through computational optimization and localized laser processing, we intend to investigate the localized heat treatment of ultra-high strength dual-phase and martensitic steel sheets for applications in the automotive industry. The forming of components in the automotive industry requires metal sheets to be thinner in order to reduce the mass of cars, thus bringing new challenges for steel producers. Although dual-phase steels comply with such ambitions since they exhibit higher elastic strength, their formability drops when considering high strength grades. Localized laser treatment can induce martensite tempering, hence enabling the possibility to adjust locally the yield strength/ductility trade-off.The approach developed can result in enhanced formability through processes based on plastic deformation, such as deep-drawing. Optimized patterns could also enhance the overall fatigue and fracture behavior.

Required background of the student: metallurgy, computational methods, engineering, materials science, applied mathematics, physics, or any other relevant field.

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

- Yang, S., Dirrenberger, J., Monteiro, E., & Ranc, N. (2018). Representative volume element size determination for viscoplastic properties in polycrystalline materials. International Journal of Solids and Structures.
- Torabian, N., Favier, V., Dirrenberger, J., Adamski, F., Ziaei-Rad, S., & Ranc, N. (2017). Correlation of the high and very high cycle fatigue response of ferrite based steels with strain rate-temperature conditions. Acta Materialia, 134, 40-52.
- Torabian, N., Favier, V., Ziaei-Rad, S., Dirrenberger, J., Adamski, F., & Ranc, N. (2016). Thermal response of DP600 dual-phase steel under ultrasonic fatigue loading. Materials Science and Engineering: A, 677, 97-105.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2013). Effective elastic properties of auxetic microstructures: anisotropy and structural applications. International Journal of Mechanics and Materials in Design, 9(1), 21-33.
- Dirrenberger, J., Forest, S., & Jeulin, D. (2012). Elastoplasticity of auxetic materials. Computational Materials Science, 64, 57-61.