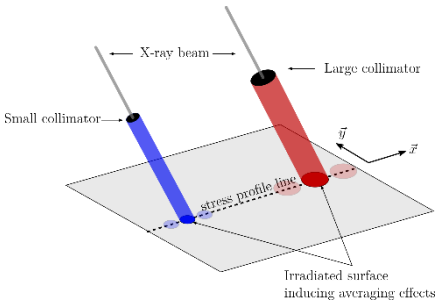
Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering

Title: Reconstruction of heterogeneous surface residual-stresses in polycrystalline materials from X-ray diffraction measurements
ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Chedly Braham & Léo Morin
Advisor(s) Email: chedly.braham@ensam.eu & leo.morin@ensam.eu
Research group/Lab: PIMM laboratory (Comet Group)
Lab location: Paris
(Lab/Advisor website): https://pimm.artsetmetiers.fr/en

Short description of possible research topics for a PhD:
Residual stresses have a significant influence on the engineering properties components such as fatigue life. X-ray diffraction (XRD) constitutes a high accuracy and non-destructive way to determine residual stresses with a very good precision and resolution in depth due to the important absorption of X-ray in metallic alloys. Despite its important success and its high precision in-depth, the X-ray diffraction method remains inaccurate in the presence of high surface stress gradients, due to averaging effects over the irradiated area. This has important consequences in processing validation because averaging effects on residual stresses measured by XRD prevent a proper comparison with the local residual stresses determined numerically by finite elements. The main purpose of this PhD is to develop a method to reconstruct heterogeneous residual-stresses at the surface of polycrystalline materials from XRD measurements. 2D maps of residual-stress will be collected on specimens obtained by several processes such as severe plastic deformation, machining or welding, using an articulated robot. A deconvolution method will be developed in order to reconstruct the local residual stress field from the average data collected. Finally, finite element simulations of the processes considered will be performed to assess the reconstructed residual stress distributions.



Required background of the student: Mechanical engineering, material science

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

1. Peyre, P., Sollier, A., Chaieb, I., Berthe, L., Bartnicki, E., Braham, C., Fabbro, R., 2003. FEM simulation of residual stresses induced by laser Peening. The European Physical Journal - Applied Physics 23, 83-88.
2. Rhouma, A.B., Sidhom, N., Makhlouf, K., Sidhom, H., Braham, C., Gonzalez, G., 2019. Effect of machining processes on the residual stress distribution heterogeneities and their consequences on the stress corrosion cracking resistance of AISI 316l SS in chloride medium. The International Journal of Advanced Manufacturing Technology 105, 1699-1711.
3. Reyes-Ruiz, C., Figueroa, I.A., Braham, C., Cabrera, J.M., Zanellato, O., Baiz, S., Gonzalez, G., 2016. Residual stress distribution of a 6061-T6 aluminum alloy under shear deformation. Materials Science and Engineering: A 670, 227-232.
4. Ezequiel, M., Figueroa, I.A., Elizalde, S., Cabrera, J.M., Braham, C., Morin, L., Gonzalez, G., 2020. Numerical and experimental study of a 5754-aluminum alloy processed by heterogeneous repetitive corrugation and straightening. Journal of Materials Research and Technology 9, 1941-1947.
5. Ben Fredj, N., Ben Nasr, M., Ben Rhouma, A., Sidhom, H., Braham, C., 2004. Fatigue life improvements of the AISI 304 stainless steel ground surfaces by wire brushing. Journal of Materials Engineering and Performance 13, 564-574.