RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Very-high-cycle fatigue strength of metals under multiaxial stress state

ParisTech School: Arts et Métiers Sciences et Technologies

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Lab location: *Bordeaux and Bejin*
(Lab/Advisor website): *http://i2m.u-bordeaux.fr and http://sourcedb.imech.cas.cn/zw/rck0/zgjzj/fxxlx/201211/t20121129_3694914.html*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The design of safe components capable to endure a very high number of loading cycles: 10^9 cycles and more, is a very important challenge for engineers in oder to guaranty very long life of products. If the fatigue strength of components can now be simulated up to 10^7 cycles under complex loadings that are representative of real multiaxial loadings and stress states, this is not the case in the gigacycle regime (10^9 cycles and more). Indeed, since the end of the last century it is known that there is no infinite fatigue life of metals. The crack initiation mechanisms are more and more understood under uniaxial loadings (tension, bending) and a few models only have been published to assess the fatigue strength of metals under such loadings in the gigacycle regime. But there is nothing published under multiaxial loadings that are representative of real load cases of components.
A few ultrasonic fatigue testing machine have been recently developed in our team to test metallic specimens under torsion or under biaxial bending. A quite comprehensive study on very-high-cycle fatigue of different materials has also been performed in our team. The aim of this PhD is to study the gigacycle fatigue strength of two metallic alloys (an aluminum one and a steel) under uniaxial (tension) and multiaxial (torsion and biaxial bending). The crack initiation and early crack growth mechanisms will be studied to propose a fatigue criterion capable to compute the very-high-cycle fatigue strength under multiaxial loadings.

Required background of the student: (What should be the main field of study of the applicant before applying?)

Solid mechanics, Mechanical engineering, Material science, Material physics

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. A. Nikitin, T. Palin-Luc, A. Shanyavskiy (2016) Crack initiation in VHCF regime on forged titanium alloy under tensile and torsion loading modes, International Journal of Fatigue, Vol. 93, pp. 318–325.
2. C. Brugger, T. Palin-Luc, P. Osmond and M. Blanc (2017) A new ultrasonic fatigue testing device for biaxial bending in the gigacycle regime, Internation Journal of Fatigue, vol. 100, pp. 619 – 626.
3. A. Banvillet, T. Palin-Luc and S. Lasserre (2003) A volumetric energy based high cycle multiaxial fatigue criterion. Int. Journal of Fatigue, Vol. 25, pp. 755-769.
4. G. Qian, C. Zhou and Y. Hong (2015) A model to predict S–N curves for surface and subsurface crack initiations in different environmental media, Int. J. Fatigue, Vol. 71, pp. 35-44.
5. G. Qian, C. Zhou and Y. Hong (2011) Experimental and theoretical investigation of environmental media on very-high-cycle fatigue behavior for a structural steel, Acta Materialia, Vol. 59, pp. 1321-1327.