

Influence of XC38 steel microstructure on crack initiation and critical distance in fretting application

Hugo Lannay¹, Siegfried Fouvry¹, Bruno Berthel¹, Camille Gandiolle², Jan Neggers²

¹LTDS, Ecole Centrale de Lyon, Ecully, France

E-mail: hugo.lannay@ec-lyon.fr, siegfried.fouvry@ec-lyon.fr

²MSSMat, CentraleSupélec, Gif-sur-Yvette, France

Keywords: fretting, microstructure, crack initiation

The phenomena of fretting and fatigue appear in several industrial applications such as aeronautics. So, these phenomena have to be considered during the design process. Usually, multiaxial fatigue criteria are used to estimate failure chances. But, in the case of strong stress gradients (as seen in fretting or fretting-fatigue), these criteria over-estimate failure chances. So, Taylor [1] proposed to use these criteria under the contact, at a distance named “critical distance” in order to have better predictions. This approach is quite interesting, but the Taylor’s approximation does not work for all stress gradient conditions [2] and does not consider the microstructure effect. Yet, as shown in multiple studies [3], the grain size of the materials has an influence in fretting.

To have a more physical description of the critical distance, the idea is to estimate this distance for several grain sizes. So, a protocol has been set. First, heat treatment has to be done on a material to change its grain size. Second, fretting experiments must be conducted to determine crack initiation threshold. Third, this threshold is put in a numerical simulation where a multiaxial fatigue criterion is applied in order to estimate the critical distance for each microstructure.

The XC38 steel has been chosen as it is easy to change its microstructure by heat treatment. Then, three microstructures have been used to conduct fretting test. For each grain size, different loading conditions have been applied in order to obtain the graphs of projected crack length as function of tangential load amplitude (Fig. 1), and then estimate the crack initiation threshold. Finally, after 2D numerical simulation, we obtain different critical distances for each grain size.

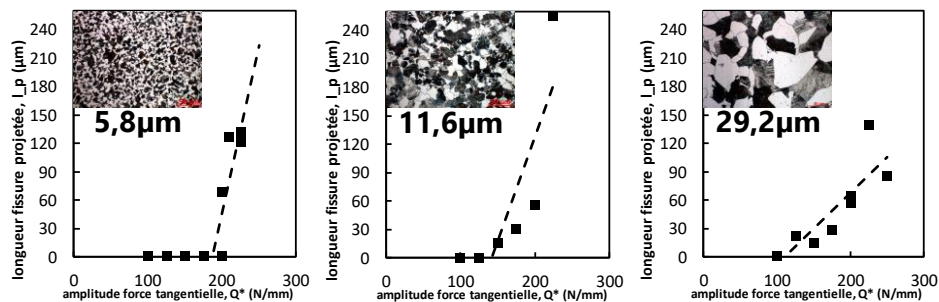


Fig. 1: Projected crack length as function of tangential load amplitude for three grain sizes

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