

Séminaire du laboratoire PIMM

Mercredi 17 avril 2019 à 13h30 en Amphi ESQUILLAN

Prof. Aude SIMAR

iMMC, Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgique

présentera dans le cadre du séminaire ses travaux intitulés :

Improving fatigue resistance of selective laser melted aluminum alloy AlSi10Mg

Metal additive manufacturing and in particular selective laser melting (SLM) is a very promising production method. SLM alloy AlSi10Mg, as a common lightweight structural alloy, has already drawn the attention of the aerospace industry due to its good strength to weight ratio. However, when aiming at reaching the requirements of highly demanding structural applications, the fatigue life of SLM AlSi10Mg does not reach the performances met by wrought aluminium alloys. The low fatigue resistance is attributed to residual stresses, the surface roughness and remaining large porosities. Improvements can be carried out in many steps of the processing chain such as actual SLM parameter optimisation and/or post-treatment.

The optimisation of process parameters has already been extensively studied for bulk AlSi10Mg and is provided by the machine manufacturers. Now, post-treatments may sometimes be unavoidable to improve the fatigue life. Hot isostatic pressing (HIP) yields very satisfactory results for Ti based AM alloys and is routinely applied in this industry, but the typical 500°C/100MPa/2h cycle used for AlSi10Mg cast parts increases ductility, but also ruins the SLM fine microstructure, depleting mechanical strength to an inadmissibly low level. In this sense, friction stir processing (FSP), a post-treatment method derived from friction stir welding that has been proven useful in Al cast material, was implemented. This post-treatment could be applied locally in regions of stress concentration more prone to fatigue failure. A significant improvement in fatigue life was demonstrated on polished bulk samples. This is attributed to the positive impact of FSP allowing to eliminate large porosities. These porosities were studied by 3D synchrotron X-ray tomography (voxel size of 0.75 μm) also involving ex-situ fatigue crack propagation. When excessive roughness is the cause of fatigue failure, other post-treatments may be envisioned. Vibro-finishing was found to be an efficient post-processing method for fatigue life improvement.

Contrarily to the bulk structures mentioned above, for thin structures (typically a couple of 100th of μm) the contouring strategy plays a dominant role on the roughness and sub-surface porosities. The surface roughness of a large variety of strategies was compared and their origin discussed. The sub-surface porosities were studied by laboratory X-ray tomography. The post-treatments mentioned previously may cause excessive deformation of very thin samples. Thus, a contour strategy optimisation is a first step towards their fatigue resistance improvement.