Centre for Mechanical Engineering, Materials and Processes

CEMMPRE

PROPOSTA DE PLANO DE DOUTORAMENTO/DOCTORAL PLAN PROPOSAL

(a ser redigido em Inglês / to be filled in English)

ORIENTADOR(A)/SUPERVISOR: Fernando Jorge Ventura Antunes

GRUPO/GROUP: A

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GRUPO/GROUP: B

LOCAL DE REALIZAÇÃO DO TRABALHO/PLACE OF WORK: DEM FCTUC

TÍTULO DO PLANO DE DOUTORAMENTO/TITLE OF THE DOCTORAL PLAN: Linking Fatigue Crack Growth to Microstructure

RESUMO/SUMMARY (max. 300 words total)

Objetivo/Objectives:

Fatigue is the main failure mechanism in components submitted to cyclic loads. In particular, for the aerospace industry it is vital to know the length of the cracks as a function of the number of cycles (or flights). Fast development of new metallic alloys and improvement of existing ones require understanding the relationship between microstructure and crack tip mechanisms responsible for fatigue crack growth. The main mechanism is cyclic plastic deformation, but additional ones are environmental damage, and growth and coalescence of microvoids. The microstructural parameters include grain size, as well as size and type of precipitates and intermetallic particles.

The main objective consists in establishing links between microstructure and crack tip mechanisms, and between these mechanisms and fatigue crack growth rate.
Resultados Esperados/Expected Results:

1. Submit metallic materials to different heat treatments, which will result in different microstructures. The alloys will be characterized by scanning electron microscopy (SEM) to determine the grain size. Transmission electron microscopy (TEM) analyses will be carried out to study the distribution of precipitates, intermetallic particles, and microvoids, inside the grains and along grain boundaries. TEM electron diffraction will allow the precipitates/intermetallic particles to be identified.

2. Evaluate the main mechanical properties. This include low cycle fatigue tests needed to develop material models. Nanoindentation tests will be performed. Hardness and Young’s modulus distribution maps should reflect the materials’ microstructure. Fatigue crack growth will be studied under constant and variable amplitude loads using non-linear crack tip parameters as crack driving force. The fracture surfaces will be analyzed by SEM to identify the main crack growth mechanisms. Fatigue specimens prepared by additive processes should also be considered, although additional defects and residual stress will be present.

3. Establishment of microstructure/crack tip mechanisms and crack tip mechanisms/fatigue crack growth relationships. The metallurgical character of fatigue crack growth will be highlighted.

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