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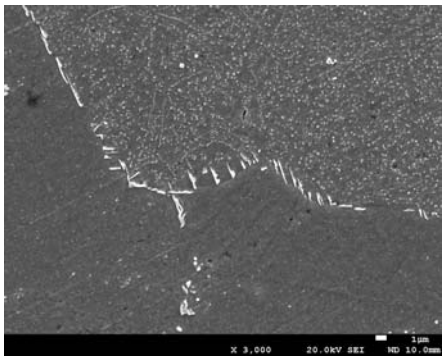
DocMASE Project Proposal 2014-07

Project Title	**Effect of the processing parameters on the precipitation of Ni-based superalloys**
Main University and Advisor	Technical University of Catalonia (Spain) Prof. Jessica Calvo and Prof. José María Cabrera
Second University and Advisor	Institut Jean Lamour - Université de Lorraine (France) Prof. Abdelkrim Redjaimia
Project Description (with **image**, if applicable)	Ni-based superalloys are high performance metals which have been extensively used for applications at high temperatures where corrosion resistance is also required. The stability of the mechanical properties at high temperatures is related to the formation of precipitates through specific aging treatments. Depending on the composition, different strengthening phases such as γ', γ'' or some carbides can appear in the austenitic γ phase and their effectiveness is strongly related to their size and distribution. In addition to the strengthening phases, other deleterious phases such as the δ phase, which can appear in Nb containing superalloys, can also form. Therefore, a deep knowledge of the precipitation characteristics of each alloy is important in order to design proper processing routes and aging treatments. Even though the precipitation kinetics have been determined for several Ni-based superalloys, the effect of the processing parameters, which has been reported to influence the characteristics of the precipitation phenomena, has not been fully assessed. In Figure 1 it can be observed how strain accumulation in partially recrystallized microstructures can induce heterogeneous precipitation. In this project, it is proposed to evaluate the effect of processing parameters on the microstructure and precipitation characteristics of Ni based superalloys. With this purpose, stress relaxation tests, which have been used in previous studies to determine the kinetics of precipitation, will be performed. The advantage of these tests is that different thermomechanical cycles can be applied to the samples prior to relaxation. Therefore, the effect of processing parameters, namely strain, strain rate and temperature, on the precipitation kinetics will be assessed using this technique. The characteristics of the precipitation in terms of the nature, size and distribution of the precipitates will be done by scanning electron and transmission microscopy. The different microstructures will also be characterized mechanically at room and high temperatures under creep conditions. The results will be used to suggest alternative processing routes, for example the possibility of direct aging after forming, in order to reduce the processing stages and energy requirements.  **Figure: SEM image of heterogeneous precipitation**
Previous Publications	Thomas, M. El-Wahabi, J.M. Cabrera and J.M. Prado, J. Mater. Process. Technol. 177 (2006) 469-472. J. Calvo, S. Shu, J.M. Cabrera, Mater. Scie. Forum, 706-709 (2012) 2393-2399.
References	H.Y. Li, Y.H. Kong, G.S. Chen, L.X. Xie, S.G. Zhu, X. Sheng, Mater. Scie. Eng. A 582 (2013) 368-373. B. Tian, G.A. Zickler, C. Lind, O. Paris, Acta Mater. 51 (2003) 4149-4160.
Requirements of the candidates / Requirements during the doctoral programme	Fluency in English. Bachelor in Materials Science, Chemistry, Physics o related disciplines. Master in Materials Science or related disciplines. 30 ECTS must been acquired during the program according to the minimum requirements of DocMASE.