Proposition of PhD. thesis at Univ. Grenoble Alpes, France

In-situ X-ray microtomographic analysis of constrained powder sintering

The functional and structural properties of sintered products depend strongly on their microstructure -porosity, grain size and homogeneity- which are themselves determined by the process conditions -temperature, holding time and atmosphere- and material properties -particle size, size distribution and composition. Where all the material properties are homogenous and isotropic and so no internal stress develops during densification, free sintering occurs, for which the mechanisms are well understood. However, most real industrial processes involve, for example, composite materials with different densification rates, powders comprising agglomerates or rigid inclusions, films sintering on substrates, or layered or graded structures with different densification rates. In these realistic conditions, constrained sintering occurs. It is thought that constrained sintering is induced by mismatch in the local sintering rates, either within the sintering material or between the sintering material and a substrate, but its mechanisms are still not fully understood. This issue will be investigated within MATHEGRAM Innovative Training Network funded by the EU (https://euraxess.ec.europa.eu/jobs/338785). The PhD could start fall 2019. The job offer will expire in August 2019.

The PhD. student hired at SIMaP laboratory of Univ. Grenoble Alpes and CNRS for this purpose will develop the means to obtain full 3D nano-tomography (nCT) images during sintering at high temperatures and thereby to explore how densification and grain growth are affected by the presence of a substrate during the entire sintering cycle, with a particular focus on the development of structural anisotropy. It will especially use the ID16B beamline high resolution at ESRF (European Synchrotron Research Facility). Through close collaboration, SIMaP and ESRF have already made unprecedented advances in in-situ observations of sintering.

The main objectives of this work will thus be :

i) to investigate constrained sintering through in-situ X-ray nano-tomography at the length-scale of particles ;
ii) to provide quantitative insights into the sintering phenomena ;
iii) to explore the development of anisotropy due to the presence of a substrate during the entire sintering cycle.

The PhD. student will work at SIMaP laboratory located in Univ. Grenoble Alpes campus. Three secondments are planned during the thesis:

i) 3x1 months at European Synchrotron Research Facilities in Grenoble to conduct the in situ nCT experiments ;
ii) 3 months at Saint-Gobain Research, Aubervilliers, France, to run X-ray microtomography analysis with a micro-tomography (µCT) scanner.
iii) 3 months at the International Centre for Numerical Methods in Engineering (CIMNE) in Barcelona, Spain, to explore modelling of constrained sintering using the Particle Finite Element Method (PFEM).

The candidates should have earned a master degree in materials science between 2015 and 2019 and they should not have resided in France for more than 12 months over the last 3 years. They should have interest and skills in experimental research activities, including numerical data processing.
The gross salary (including social security costs) is 2 800 € per month, during 3 years.
Further information and application, please contact Didier Bouvard : didier.bouvard@grenoble-inp.fr