Imperial College London

K.Marquardt@imperial.ac.uk

PhD position in the Centre for Doctoral Training for Advanced Characterization of Materials (CDT – ACM): **Extreme ceramics: controlling properties via crystal shape engineering by pre-melting**

The surface of most crystals that build up ceramics are very sensitive to interaction with a melt phase and different fugacity and or impurities related to processing. Often control of these parameters is achieved via the introduction of wetting liquids (melts) that allow for better sintering properties. The overall effect of these wetting liquids is well established, their effect on crystal faceting, crystal shape and the localized effects of the grain boundary chemistry on overall material properties are however not understood.
In this project we aim to experimentally evolve different microstructures and quantitatively assess their characteristics, including the grain boundary plane distribution (example in Fig 1). Recent developments in quantitative microscopy where EBSD and TEM are spatially correlated allow the determination of (i) interfacial compositions and the distribution of very small melt phases (ii) interfacial areas of different crystallographic surfaces, which are inversely related to the magnitudes of interfacial energies (e.g.
The quantified textural changes will be described using adapted existing grain growth laws and equilibrium melt distribution models.

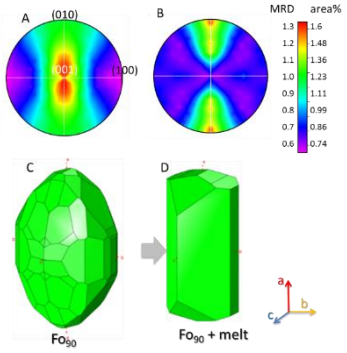

Fig.1: Compilation of preliminary experimentally determined grain boundary plane distribution (GBPD) (A & B) and the average crystal shapes calculated from the relation between GBPD and interface energy (C & D). The surface energy strongly changes from dry polycrystalline sample (A & B) compared to a wetted aggregate (B & D). The addition of melt renders the crystal shapes even more anisotropic. Mind the rotation between the crystal reference frames between the GBPD and the average crystal shapes.

The student will work in a team with experts in various fields and a spirit of working together. While the group has common overarching goals, we work on independent projects. In this project the student's role will be to use high pressure synthesis to produce the samples and characterize the material using novel scanning electron microscopy techniques as developed for electron backscatter diffraction (EBSD) and transmission Kikuchi diffraction (TKD) along low dose high resolution scanning transmission electron microscopy (HR-STEM). Additionally, atom probe tomography (APT) and infrared spectroscopy will be employed to study the interfacial structure and composition of the ceramics at the bulk and nm-scale.

During their PhD the candidate will become proficient in ceramic processing, sol-gel sintering techniques, as well as structural and chemical characterization techniques. They will develop strong skills in the scientific approach, problem solving, and the communication of scientific results and in collaborative working in an international team.

We are seeking applications from excellent, motivated, and curious candidates with a minimum 2:1 (or equivalent) first degree in Materials Science, Physical Chemistry, Mineral Physics or Applied Geosciences for a four-year PhD studentship, eligibility criteria can be found on the webpages below. The project will be based in the Centre for Advanced Structural Ceramics (http://www3.imperial.ac.uk/structuralceramics) and the Centre for Doctoral Training for Advanced Materials Characterization (http://cdt-acm.org/) at the Department of Materials at Imperial College London (Katharina Marquardt) and Earth Sciences at University College London (Andrew Thomson).
Applications will be processed as received. For questions or further details regarding the project, please contact Dr Katharina Marquardt, k.marquardt@imperial.ac.uk .

To apply for this PhD opportunity in the CDT for ACM and the eligibility criteria please visit:
https://www.cdt-acm.org/phd-opportunities/ and look at: http://www.cdt-acm.org/imperial-and-ucl-projects/
Engineering materials: **Extreme ceramics: controlling properties via crystal shapes engineering by pre-melting**
And **In-service catastrophic failure: or controlling the grain boundary network evolution**