In-situ fast X-Ray tomography investigation of microstructural changes occurring during solidification and partial remelting of Al-Cu alloys

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The understanding of some fundamental mechanisms in metallurgical science requires 3D visualisation of the material evolution during thermal treatment. This can be achieved only by performing in situ 3D tomography experiments at a spatial resolution of the order of few microns. The main constraint is the time duration of a complete scan (acquisition of radiographs over 180°) which needs to be less than 30s. This is now possible at ESRF thanks to the high photon flux, the very fast cameras (DALSA or the latest FReLoN 2k) and the optimisation of the micro-tomograph set up at ID15 and ID19. We investigate the partial remelting at constant temperature and the solidification of Al-Cu alloys using ultra fast micro-tomography in order to get local information of the structural evolution. Thanks to 3D quantitative image analysis we were able to characterise the structure evolution at the scale of several solid particles or dendrite arms and identifying the physical mechanisms that are taking place, namely dissolution-reprecipitation and coalescence for partial remelting. In the latter case, these mechanisms occur in a competitive way so that complex evolution of the microstructure can be observed depending on the neighbourhood of the solid particles or dendrites under investigation. These results confirm that in-situ X-Ray micro-tomography is a very powerful tool to observe in real-time the mechanisms that act on the microstructure of an alloy when it is in the mushy state.