Modelling of Microstructure Evolutions due to Phase Transformations in Titanium Alloys

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Most titanium alloys are deformed in the high temperature range where the most stable phase is b (bcc) and further cooled to room temperature where the material is a mixture of b and a (hcp) phases. Different morphologies of the a phase are observed depending on the cooling rate and the previous deformation conditions: for small departures from equilibrium conditions, a allotriomorph grains at the b grain boundaries are first observed. For greater departures from equilibrium conditions, plates of Widmanst?tten type seem to have grown from the allotriomorph grains. And finally, for the greatest departures from equilibrium conditions, acicular a grain are observed inside the b grains.

Here we focus on a allotriomorphs. First steps in the modelling of the growth kinetics under isothermal conditions will be introduced.

At first, we will present a simple 1D sharp interface model, assuming that the allotriomorph grains result from a 1D growth process controlled mainly by diffusion. This model relies on the following features: a phase is considered to be stochiometric; interface is assumed to be at local thermodynamic equilibrium; and chemical diffusion for each of the alloying elements (Al, Mo, Cr, Fe) is described with Fick's law, neglecting cross diffusion.

Because we aim at investigating some 2D phenomena such as, for instance, the apparition of Widmanst?tten plates from allotriomorph grains, we have planned to use a phase field model in parallel to thorough experimental studies. Our choice has fallen on the phase field model developed by Kim, Kim and Suzuki [Phys.Rev. E 60, 7186 (1999)] for the solidification of metallic alloys, because this model seems to give good predictions on evolution kinetics. So, we will present our first steps in the application of this model to our multi-component titanium alloy: a comparison between sharp interface and phase field models in the case of the 1D growth of allotriomorph a grains.