PROPOSAL FOR A POST-DOCTORAL POSITION

MATHEMATICAL MODELLING OF THE SOLIDIFICATION OF VACUUM ARC REMELTED INGOTS

Project scope:

This work is part of a long-term study, during which a mathematical model of the VAR (Vacuum Arc Remelting) process, known as SOLAR (SOLidification during Arc Remelting), has been developed for more than 15 years at LSG2M (Nancy School of Mines). The software is currently used by several companies, in France (Aubert&Duval – Eramet, Cezus – Areva, Timet Savoie) and abroad (Timet UK Birmingham, Timet US Henderson), as a tool for optimizing the vacuum remelting of various metallic materials, such as specialty steels, Ni-base superalloys, titanium and zirconium. It has been intensively validated through the comparison of numerical simulation results with the observation of ingots remelted in pilot plants or full-scale furnaces.
At the same time, LSG2M researchers have set up a general and comprehensive modelling of both the formation of solidification structure and development of chemical segregation induced by the solidification process. In particular, this modelling enables accounting for the competition between columnar growth and equiaxed solidification of metallic alloys, as well as the settling of equiaxed grains during the solidification of steel or aluminium.

These two in-house models are based on the numerical solution of coupled transient fluid flow, heat transfer and mass transfer phenomena.

Position:

The purpose of the post-doctoral position proposal is an association of models, i.e. the implementation of a detailed solidification model, at the microscopic scale, as part of the SOLAR code. The following will be particularly addressed:

1) the post-treatment calculation of a columnar-to-equiaxed transition (CET) criterion,
2) the variation of mushy zone permeability as a function of the solidification structure of the alloy (columnar vs. equiaxed, dendrite arm spacing,…),
3) the computation of coupled segregation and solidification path (i.e. the evolution of liquid fraction with the temperature and local solute content),

Application spans the whole range of alloys processed by Solar User's Club members: steels, superalloys, Ti and Zr.
An important part of the study is to set the frame for a next Ph.D. thesis, which will address either the genesis of porosity and final shrinkage caused by the density difference between the solid and liquid metal, or the motion and physical behaviour of equiaxed grains into the liquid pool of a VAR ingot.

This 1-year post-doctoral position is financed by LSG2M, in the frame of industrial contracts. We look for a person who is ready to work in close collaboration with industrial R&D

Required skills:

Doctor's degree in Materials Engineering or Mechanical Engineering, with some skills in the field of numerical simulation, or solidification of metals, or both.

Starting date: as soon as possible

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