Congress on Numerical Methods in Engineering
Lisboa, June 29 to July 02, 2015

RESUMO N° 314

IMPORTANT INPUT TO MODELLING SOLIDIFICATION

Dieter Herlach, dieter.herlach@dlr.de
German Aerospace Center, Germany

Keywords: Containerless Processing of Liquid Metals, Undercooling, Thermophysical Properties of Liquid Metals, Crystal Nucleation, Dendrite Growth Kinetics, Sharp Interface Modelling

One of the most important phase transitions is solidification, since most of materials in daily human life are prepared from the liquid state as their parent phase. The design of materials requires post-solidification treatment in order to obtain the material with its desired properties. To date, efforts are directed to virtual materials design to save costs and energy consuming treatment of the material connected with the trial and error procedure. Virtual materials design requires accurate knowledge of the thermo-physical properties of the respective liquid, knowledge of the physical mechanisms involved in solidification and appropriate computer assisted modelling. In the present paper electromagnetic and electrostatic levitation is applied to containerlessly process drops of liquid metals and alloys. The freely suspended drop gives direct access to measuring thermo-physical properties even in the largely undercooled melt, to investigate crystal nucleation, phase selection and dendrite growth as a function of undercooling. A sharp interface model is presented to model dendrite growth in undercooled metals. Examples are presented for measurements of surface tension and viscosity, to study crystal nucleation and associated phase selection and measurements of rapid dendrite growth velocities in undercooled melts. All these processes are controlling solidification of a specific material and therefore the physical and chemical properties of the as solidified species. Its accurate investigations are mandatory for a valuable computer assisted virtual materials design to improve production processes.