EuroSciCon

17th Edition of International Conference on

Emerging Trends in Materials Science and Nanotechnology

April 26-27, 2018
Rome, Italy

Nano Res Appl, Volume:4
DOI: 10.21767/2471-9838-C1-009

CONTAINERLESS UNDERCOOLING AND SOLIDIFICATION OF METALS AND ALLOYS

Dieter Herlach
Ruhr-Universität Bochum, Germany

An undercooled melt possesses an enhanced free enthalpy that gives access to crystallize metastable solids. Crystal nucleation selects the crystallographic phase whereas the subsequent crystal growth controls the microstructure evolution. Electromagnetic and electrostatic levitation techniques are very efficient to produce a highly undercooled melt since heterogeneous nucleation on container-walls is avoided. Moreover, a freely suspended drop is accessible for in situ observation of crystallization far away from equilibrium. We combine levitation technique with the diagnostic means of neutron scattering to investigate short range order in undercooled melts and energy dispersive x-ray diffraction of synchrotron radiation to observe phase selection processes upon undercooling. Measurements of the statistics of nucleation undercooling are performed in order to study the physical nature of crystal nucleation. Nucleation is followed by crystal growth. In undercooled melts the crystal grows with dendritic morphology since a planar interface is destabilized by the negative temperature gradient ahead the solid liquid interface. In highly undercooled melts dendrites propagate very rapidly. A high speed camera is used to record the advancement of the solidification front. Dendrite growth velocities are measured as a function of undercooling of pure metals, solid solutions and intermetallics. Non-equilibrium crystallization effects are evidenced. Crystal growth is governed by heat and mass transport. To explore the influence of convection on dendrite growth comparative experiments in microgravity are performed using an electromagnetic levitator on board the International Space Station. Metals show dendritic growth in a mesoscopic scale with a rough interface at the microscopic scale. In case of semiconductor, the solidification front is facetted in a mesoscopic scale with a smooth interface in a microscopic scale. The entropy of fusion of the compound Ni2B is located in between that of metals and semiconductors. A transition from dendritic to facetted growth is observed induced by convection in the undercooled drops.

dieter.herlach@dlr.de