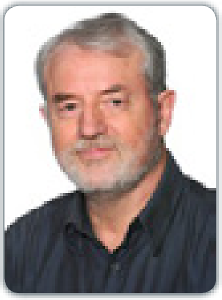
Dieter Herlach, Struct Chem Crystallogr Commun, 3:2
DOI: 10.21767/2470-9905-C1-001

2nd International Conference on

# Applied Crystallography

October 16-17, 2017 | Chicago, USA



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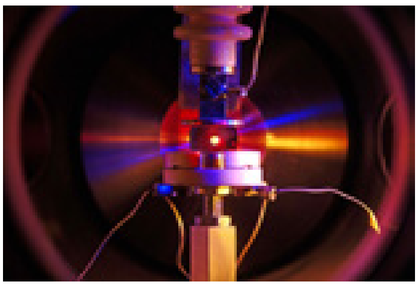
### Crystal nucleation and growth in undercooled melts of metals and alloys

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 in the International Space Station. Metals show dendritic growth in a mesoscopic scale with a rough interface at the microscopic scale. In case of semiconductors the solidification front is facetted in a mesoscopic scale with a smooth interface in a microscopic scale. The entropy of fusion of the compound $Ni_2B$ 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.



### Biography

Dieter Herlach as studied Physics at the RWTH Aachen and received Doctoral degree as Dr. rer. nat. at the same university. He became private lecturer upon a Habilitation at the Ruhr-University Bochum RUB. Presently, he is Group Leader at the Institute of Materials Physics in Space and Senior Scientist of the German Aerospace Center, Germany. He is a Full Professor of Physics at RUB. He has authored over 300 scientific publications in refereed journals. He is author and Editor of six books and Co-Editor of *Advanced Engineering Materials*. He leaded and leads projects of the German Research Foundation, the German Aerospace Center-Space Management, the European Space Agency and was the Principal Investigator of NASA during three spacelab missions. He is an Honorary Professor of three universities and received Chinese Friendship Award in Beijing in 2000 and the Lee Hsun Lecture Award of the Chinese Academy of Sciences in 2007. He has chaired the Division of Metal and Materials Physics of the German Physical Society DPG and was elected as Member of the Council of DPG. He was an elected Member of the General Review Committee of DFG and Deputy Chairman of the German Society of Materials Science and Engineering.

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