MICROGRAVITY SCIENCES AND PROCESSES (A2)
Microgravity Processes onboard Large Space Platforms (7)

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MULTIPHASE TRANSFORMATIONS OF GLASS-FORMING ALLOYS INVESTIGATED ON EARTH AND IN REDUCED GRAVITY

Abstract

We describe and motivate experiments to be performed on board the International Space Station (ISS). Within the project, it is envisaged to measure the crystal growth velocity as a function of undercooling of intermetallic Cu50Zr50 and eutectic Cu56Zr44 alloy. Applying electrostatic levitation the intermetallic Cu50Zr50 alloy can be deeply undercooled (up to 310 K [1]). That is in the vicinity of the glass transition temperature of the glass-forming alloy Cu50Zr50. Measurements of the dendrite growth velocity as a function of undercooling show a maximum of the growth velocity at an undercooling of about 200 K. At undercoolings $\Delta T <¡ 200K$ growth is dominated by the monotonic increase of Gibbs Free Energy difference of solid and liquid while at undercoolings $\Delta T >¿ 200$ K the rapid decrease of the diffusion coefficient becomes dominant. So far it is not possible to model the observed velocity undercooling relation by dendrite growth theory, because mass transport is essentially affected by convection. Therefore, equivalent experiments on board the ISS using the multiuser facility of Electro-Magnetic Levitator (EML) currently under development by DLR/ESA are scheduled for 2012/2013. Also in the case of the eutectic Cu56Zr44 alloy, the growth kinetics is controlled by diffusion and strongly dependent on convective transport. In addition to the problems in these binary alloys, the role of spinodal decomposition on the transition of the liquid to amorphous phase is investigated in Zr58.5Cu15.6Ni12.8Al10.3Nb2.8 [2] and Pd40Cu30P20Ni10 alloys. Both alloys are belonging to bulk glass-forming alloys, which can be transferred to amorphous state by moderate cooling rates. The former shall be processed in the EML within the COLUMBUS module of ISS while the latter one shall be studied using the Russian Multi Zone Electro Vacuum (MZEV) furnace currently under development by ROSKOSMOS on board the Russian module of the ISS. We acknowledge support from DFG (German Research Foundation) under the Project No. HE 160/19 and DLR Space Management under contract 50WM1140.