IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

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HOW MICROGRAVITY EXPERIMENTS CAN HELP TO SOLVE CURRENT PROBLEMS DURING PRODUCTION OF SILICON CRYSTALS

Abstract

Current and future microelectronic as well as photovoltaic systems are based on silicon crystals which are produced either by crystal pulling from melt after the Czochralski technique or by directional solidification of the melt contained in a crucible. The transport phenomena in the melt which are strongly influenced by gravity are determining the process stability and the material quality during industrial production of silicon crystals. For example during production of silicon for solar cells the silicon melt is contaminated by nitrogen and carbon. When the solubility limit in the melt is exceeded, SiC and Si3N4 particles are formed. Such particles are harmful for the further production process and reduce the efficiency of the solar cells. For these reasons, the incorporation of such particles needs to be avoided. Another example is heavily doped Czochralski silicon which is needed for power electronic devices. Here the growth phenomena at the transition between a facetted and non-facetted solid-liquid interface are thought to be responsible for a reduction of the crystal yield during industrial production. These growth phenomena are again strongly affected by temperature fluctuations which occur due to unsteady melt convection. In this paper we present now how crystal growth experiments recently carried out under microgravity conditions onboard TEXUS missions 51 and 53 or planned for future sounding rocket flights will help to get a better understanding of the basic phenomena occurring during silicon crystal growth and how these findings can be transferred in order to solve current problems during production of multicrystalline silicon for photovoltaics and of heavily doped silicon for power electronics.