Technische Universität Dresden Fakultät Elektrotechnik und Informationstechnik Institut für Regelungs- und Steuerungstheorie Prof. Dr.-Ing. habil. Klaus Röbenack

₹RST<u></u>→

Topic for a diploma thesis (industrial research project in Norway): Reconstruction of the crystal diameter from measurement of the bright ring diameter in Czochralski crystal growth

The Czochralski crystal growth process is a key technology for the production of high quality single crystals used for micro- und opto-electronic purposes as well as for photo-voltaic applications. In this process the crystals are grown freely from the melt in a crucible by slowly pulling a seed in upward direction after having connected it with the melt surface. Simultaneously, the temperature of the heaters surrounding the crucible is adjusted in such a way that a crystal of well defined shape is grown. Although the crystal diameter is a very important process quantity needed to be controlled it cannot be measured directly. Instead, the diameter of a so-called bright ring is measured by a camera system. The bright ring results from reflections of the red hot glowing inner assemblies of the furnace on the meniscus. The meniscus is the curved melt area between the lower crystal end and the free melt surface. The bright ring



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diameter is always slightly larger than the real crystal diameter at the solid-liquid interface. Unfortunately, its dynamics shows an inverse response behavior, i.e., the bright ring diameter temporarily decreases if the crystal diameter starts to increase and vice versa. This effect significantly degrades the performance of the overall

In this thesis an algorithm has to be designed that is able to reconstruct the crystal diameter from the measured bright ring diameter and which is not affected by the inverse response behavior. Mathematical models describing the effect are already available. The task has to be solved by simulation studies on simulated and real world data as well as by implementing it on a test plant.

The thesis is written as part of an industrial research project together with NorSun AS and the Norwegian University of Science and Technology (NTNU), Department of Engineering Cybernetics (Prof. Morten Hovd), Trondheim. During the thesis one or two one week stays in Trondheim and/ or the production plant in Årdal are required. Costs for travel and accommodation will be paid by the institute. Written language of the thesis is English, project language in Norway is English, too.

Students applying for this thesis should be *highly motivated* and should provide a *high level* skill in MATLAB programming.

Starting date: As soon as possible. Alternatively, an application via Erasmus is possible for a full 3-6 month stay in Trondheim (requires a lead of 6-12 month).

Contact:

control system.

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