Special Issue to Commemorate the Work of Professor Jan Czochralski

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Preface

Both, modern electronics and optoelectronics, require multiple single crystalline components of good quality and specific level of defect concentration. In recent years, Czochralski-grown crystals have been increasingly used in various domains of science and technology. The Czochralski method has been used extensively as a source of crystals helping to understand the atomic structure, optical properties, electronic structure and magnetic ordering of various advanced functional materials. The crystals grown by the Czochralski method contributed more and more to solid state physics. The method plays also an important role in science, as it is one of very few melt growth methods that in a high degree satisfy optimal combination of high quality, large dimensions, and reasonable cost of produced crystals. Now, the method has become a routine tool for producing crystals for commercial electronics.

After the invention (1916), the Czochralski growth method [J. Czochralski, *Z. Phys. Chem.* **92**, 219 (1918)] was applied first to metallic elements. Later it was extended to nonmetallic crystals. The first of them was NaCl, in 1937 [H. Walther, "Rev. Preparation of Large Single Crystals of Sodium Chlorine", *Sci. Instrum.* **8**, 406 (1937)] (the growth of other halides was reported later, in 1959 [S Amelinckx, W. Maenhout-Van Der Vorst, W. Dekeyser, "Cavity formation in nitrate-doped alkali halides", *Acta Metall.* **7**, 8 (1959)]). The growth of group-IV semiconductor (germanium) started in 1950 ["Growth of Germanium Single Crystals", *Phys. Rev.* **78** , 647 (1950); G.K. Teal, M. Sparks, E. Buehler, "Growth of Germanium Single Crystals Containing $p-n$ Junctions", *Phys. Rev.* **81**, 637 (1951); G.K. Teal, E. Buehler, "Growth of Silicon Single Crystals and Single Crystals Silicon $p-n$ Junctions", *Phys. Rev.* **87**, 190 (1952)], III-V semiconductors — in 1958 (AlSb) [A. Herczog, R. R. Haberecht, A. E. Middleton, "Preparation and Properties of Aluminum Antimonide", *J. Electrochem. Soc.* **105**, 533 (1958)], oxides — in 1960 (scheelite-type $CaWO_4$) [K. Nassau, L.G. Van Uitert, "Preparation of Large Calcium-Tungstate Crystals Containing Paramagnetic Ions for Maser Applications", *J. Appl. Phys.* **31**, 1508 (1960) , K. Nassau, A.M. Broyer, "Application of Czochralski Crystal-Pulling Technique to High-Melting Oxides", *J. Am. Ceram. Soc.* **45**, 474 (1962); K. Nassau, A.M. Broyer, "Calcium Tungstate: Czochralski Growth, Perfection and Substitution", *J. Appl. Phys.* **33**, 3064 (1962)], fluorides in 1961 (divalent fluorides) [K. Nassau, "Application of the Czochralski Method to Divalent Metal Fluorides", *J. Appl. Phys.* **32**, 1820 (1961)]. The most recent class of materials grown by Czochralski method are single quasicrystals (the first was Al70Pd20Mn10, in 1992) [Y. Yokoyama, T. Miura. A.P. Tsai, A. Inoue, T. Masumoto, "Preparation of a large Al70Pd20Mn10 single-quasicrystal by the Czochralski method and its electrical resistivity", *Mater. Trans.* **33**, 97 (1992)]. During the last decades, the work on the method concentrated on the crystal size and quality. In parallel, the existing methods of structural quality have been continuously improved and new experimental and computational techniques became available.

The present issue of *Acta Physica Polonica A* contains 28 papers invited in order to commemorate Professor Jan Czochralski through presentation of reviews and recent results related with the Czochralski crystal-growth method. The authors of the collected articles originate from 14 countries of Europe, North and South America and Asia, with the strongest representation of Poland, Germany, Japan, Russia and Ukraine. The content is divided into six sections composed from several articles each. The contributions of the first part are dedicated to the inventor, Jan Czochralski, and to a bibliometric resumé of his achievements. Section 2 includes studies of the growth process and of the prospects of the future commercial growth of one of important materials (sapphire). Growth of group-IV semiconductors is collected in Sect. 3, of oxide and fluoride materials - in Sect. 4, intermetallics and quasicrystals - in Sect. 5. In the last, fifth section, the review papers on the defect structure studies, and on applications in radiation detectors are collected. The given division into sections is not univocal, because some papers would match more than one section. a wide variety of subjects and materials studied gives a nice overview of the state of the art of the Czochralski growth method. The Guest Editors would like to draw the readers' attention on several review papers which show the status of the specific domains or summarize the crystal results obtained during last decades in particular laboratories. They deal, for example, with automating the growth process, laboratory and synchrotron methods of imaging the defect structure, scintillating and laser materials.

The Guest Editors are grateful to all contributors and referees for their tedious work and prompt cooperation during the editing process. We hope that the contributions collected will serve to the scientific community in the future development and application of the Czochralski method.

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European Action towards Leading Centre for Innovative Materials

On the 1st June 2013 the Institute of Physics, Polish Academy of Sciences (IF PAN) has started a new project: "European Action towards Leading Centre for Innovative Materials" **(EAgLE)**. The aim of the project is to establish within the Institute a leading multiprofile research Centre for designing and fabricating new materials, their characterization and testing under extreme experimental conditions. **The project is financed by the European Union's 7th Framework Programme under the grant agreement REGPOT-CT-2013-316014.**

IF PAN has a long and well documented track record in setting new directions in physics of materials and in pioneering studies of the structure–property correlation at different scales. In order to bring the corresponding research and innovation potential to a higher level and to make the Institute a pro-creative centre for the regional development, the activities of the EAgLE Centre are focused along three axes, cross-cutting through the organizational scheme of IF PAN.

- Development of new materials, structures and devices aimed at enhancing their potential applications and new or better functionalities. The emphasis is on the improvement of existing methods and on inventing new means of material and nanostructure fabrication, bearing in mind their impact on the environment and abundance of the constituting elements.
- Introduction of new and upgrading the existing research tools and protocols for element specific and spin sensitive characterization of materials with nanoscale resolution in three dimensions, available also for external users (academia and industry – including SMEs).
- Development and standardization of user-friendly computational methods for materials design and modelling of functional properties, including code validation and benchmarking, available also to external users.

The innovative research potential will be stimulated by (i) know-how exchange with leading European partnering organization, (ii) upgrading human capacities and research infrastructure, (iii) links with the socio-economic environment, the region and industry.