Lecture
Crystal growth: Physics, technology, and modeling
Academic year 2022-2023 Semester II

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http://w3.unipress.waw.pl/~stach/cg-2022-23/

Description

The development of information technologies, includes the design and fabrication of new electronic devices of nanometer size, the emergence of new molecular diagnostic techniques (e.g. for medical purposes) requires understanding of the basics of the methods of design and fabrication of the new materials and structures. This course will cover problems of the understanding, design, fabrication and determination of the properties of nano-structures and nano-materials, forming an introduction to nanotechnology. Therefore the subject of the lecture will be devoted to the basic methods of crystal growth, both volumetric, at the macro scale, and quantum structures of the dimensions in micro and nano range. Currently, courses in physics, chemistry or material engineering in Poland, both in Warsaw and in other cities, do not include lectures on the fundamentals of crystal growth. Therefore the students working in these areas need additional training. The program proposed below includes a course in the fundamentals of crystal growth (especially of semiconductors), both from a theoretical point of view and a review of the main growth techniques and characterization methods. We assume that this course will not be an exhaustive description of the subject. Instead, it will provide a sufficient foundation for understanding the field, while providing a good starting point for further independent study in the future research work. The course is intended for PhD students that they have mastered the basics of quantum mechanics, statistical mechanics and solid state physics at the university level. At the end of the year-long lecture series we foresee a visit of the students to the crystal growth laboratories of the Institute of Physics PAS and the Institute of High Pressure Physics PAS in Warsaw. This will allow interested students to familiarize themselves with the existing experimental facilities and with details of the research work in progress.

Technical notes

The lectures will be given on Wednesdays at 9.00 in the premises of the Institute of Physics Polish Academy of Sciences.

The links in the title will provide access to pdf file of the lecture. Usually this will be in the preceding week. The student could download the lecture and look BEFORE the lecture. The students are strongly encouraged to do that.

Any students interested in physics and technology, from Warsaw4PhD School, but also from other partner institutions in Warsaw are invited to the lecture.

Semester II

I. Growth of crystals and epitaxial structures

1. Epitaxy – an introduction (Zbigniew R. Żytkiewicz - Institute of Physics PAS) 22.02.2023
2. Bulk crystal growth from gas phase (Michał Boćkowski - Institute of High Pressure Physics PAS) 01.03.2023
3. Growth of bulk crystals from the melt or solution. (Tomasz Słupiński - Institute of Physics PAS) 08.03.2023
4. Molecular beam epitaxy (Zbigniew R. Żytkiewicz - Institute of Physics PAS) 15.03.2023
5. Molecular beam epitaxy of nitride semiconductors (Zbigniew R. Żytkiewicz - Institute of Physics PAS) 22.03.2023
6. Gas phase epitaxy (Michał Leszczyński - Institute of High Pressure Physics PAS) 29.03.2023
7. Liquid phase epitaxy and lateral overgrowth of semiconductors (Zbigniew R. Żytkiewicz - Institute of Physics PAS) 05.04.2023
8. Atomic layer deposition (Elzbieta Guziewicz - Institute of Physics PAS) 12.04.2023

II. Characterization of crystals and epitaxial structures

9. X-ray diffraction studies of crystals (Michał Leszczyński - Institute of High Pressure Physics PAS) 19.04.2023
10. Selected methods of transmission electron microscopy (Sławomir Kret - Institute of Physics PAS) 26.04.2023
11. Electrical characterization of semiconductors and semiconductor based structures (Ramon Schifano - Institute of Physics PAS) 10.05.2023
12. Surface studies of crystals (Bogdan Kowalski - Institute of Physics PAS) 17.05.2023
13. Optical properties of crystals (Piotr Perlin - Institute of High Pressure Physics PAS) 24.05.2023
14. Secondary ion mass spectrometry (Paweł Michałowski – Łukasiewicz Institute of Microelectronics and Photonics) 31.05.2023
15. Electronic and optical properties of graphene and other 2D materials (Andrzej Wysmołek – Faculty of Physics University of Warsaw) 07.06.2023