



INSTITUTE OF MICRODEVICES
Ukrainian center for micro- &
nanotechnologies



Annual Report | 16

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IMD Annual Report, 2016
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Institute of Microdevices,
Ukrainian center for micro- & nanotechnologies
National Academy of Science of Ukraine

CONTENTS

| | |
|---|-----------|
| IMD at a glance | 4 |
| Purpose | 5 |
| Values | 5 |
| Vision | 5 |
| Mission | 5 |
| Financing | 5 |
| Structure | 5 |
| Membership | 6 |
| Benefits of Membership | 6 |
| IMD Infrastructure | 7 |
| Contribution to industry & Academia | 8 |
| Dept. of technological & analytical research | 9 |
| Dept. of Nuclear-Physical and Radiation Instruments | 10 |
| Dept. of Integrated Circuits | 11 |
| Partnership with industry & Academia | 12 |
| Publications | 14 |





at a glance

Established in 1966, IMD is the only State enterprise in Ukraine that has all the necessary infrastructure for researches and manufacturing from various disciplines (micro- and nanoelectronics, in particular). Being a leading force in the field of microelectronics, IMD set a challenge to become a center of excellence in nanotechnology with top-notch research facilities and highly qualified personnel. Our partners and particular members include active R&D companies, organisations, research institutes and laboratories with interests in the manufacture and use of micro- nano(optoelectronic) devices, available facility, intellectual property etc. IMD is the scientific forum where member company experts meet and co-operate with R&D representatives and academic scientists, to evaluate and assess the available data, identify gaps in knowledge and recommend research, and publish critical reviews on the material science and nanotechnologies, solid state chemistry/physics/electronics, optics, micro- nano(opto)electro mechanical systems.

IMD also provides scientific representation for its members by participation in the scientific activities of international conferences, work-shops and professional societies. As a State Enterprise and research center in the same time, IMD prides itself on the objectivity and integrity of its work programme, the output of which is published in the form of peer-reviewed reports and research articles in high impact journals.



Purpose

The purpose of IMD is to create a background for fruitful development and progressive motion of nanotechnology in Ukraine, and comfortable work conditions for young researchers in the field of material science and nanotechnology via implementation of best European practices. These will allow to strengthen the competitiveness of Ukrainian products in both internal and external markets, hence to contribute to the innovative development & improvement of living standards all around the world.

Values

IMD has strong values of science and young researcher integration into world research community in the field of material science and nanotechnology.

Vision

IMD possesses as a research & industrial center that engaging high qualified researchers, research groups and industry in the development of emerging technologies and concepts based on fundamental and applied science to create high-tech social-, military-oriented and dual-use products.

Mission

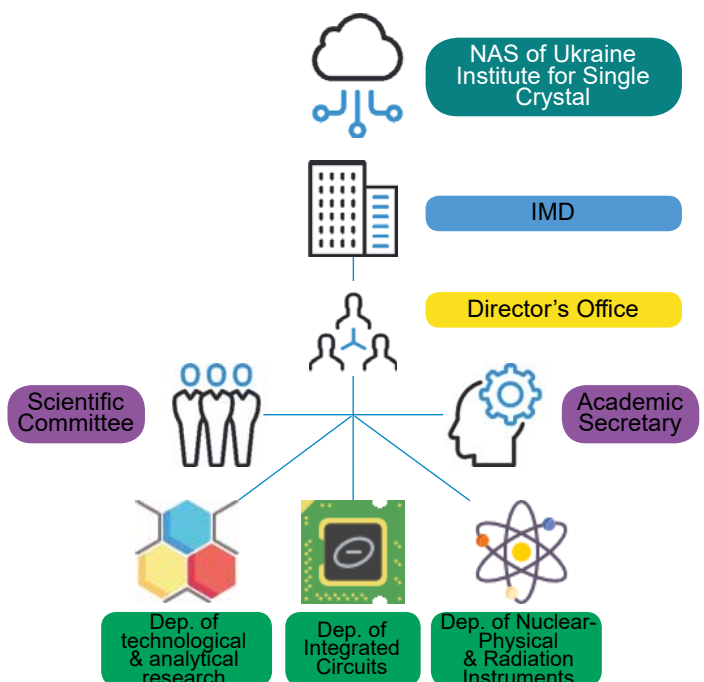
Our mission is to train & engage experts & young researchers through our fields of interest, development, fabrication & implementation of a new and high-tech products based on micro- & nanoscale devices fabrication to strengthen the competitiveness of Ukrainian products in international markets and hence to contribute to the innovative development & improvement of living standards in Ukraine.

Finance

IMD is financed (1) from State based research projects; (2) from European based (or other similar types) research projects; (3) rent of premises; (4) by investors who are interested in solving specific challenges; (5) charity activity of people/organisations who cares about the development of Ukrainian science.

Structure

IMD is a part of National Academy of Science of Ukraine from the side of Institute for Single Crystals. IMD is managed by Directorate office and Scientific committee that set the trend of institute development. IMD consists of three main research departments: Department of technological & analytical research; Department of Nuclear-Physical and Radiation Instruments; Department of Integrated Circuits.



Benefits of Membership



- As a recognised scientific State Enterprise, IMD can be a center of nanotechnology research and manufacture development for researchers and companies all around the world who are interested in conducting collaboration between research groups from different fields.
- Status of IMD member and Scientific Committee representative for group leaders.
- As the number of researchers and projects is increasing, IMD is becoming a hub for nanotechnology research.
- Membership can influence the scientific agenda of IMD through the Scientific Committee, which approves and leads the IMD work programme.
- Membership can also influence the scientific agenda of IMD by participating in the annual review meetings.
- Membership can also create an opportunities for researchers and research groups to create a spin-off companies based on intellectual properties achieved at IMD.

Capacity Building

Through the use of IMD facility, researchers and engineers background and expertise, IMD provides a platform for training and development of scientists, development and implementation of high-tech products based on micro- and nanotechnologies. Through the use of expert meetings, taskforces, workshops and facilitating scientific research, IMD provides a platform for training and development of general vision of Ukrainian science development.

Networking

Participate in IMD task forces, workshops and other meetings. Access to the established contacts with well-known research laboratories, centers and companies all around the world.

Join IMD

- By joining IMD, you will contribute to the global and Ukrainian science and industry in the fields of material science and nanotechnology, solid state chemistry/physics/electronics, optics, micro- nano(opto)electronics, that can be used for biomedical, energy-saving, surface protection, defence and dual-use applications.
- Near 25 types of technological and 20 types of diagnostical equipment are available.
- Facility usage fee discount for internal users.
- Membership is open to:
 - research groups who provide cutting edge research,

- companies who manufacture or interested in utilizing products based on micro- and nanotechnologies.

To apply for membership Contact the IMD Secretariat:

Telephone: +038-044-434-72-77

Email: radkevich@imd.org.ua

Email: petro.deminskyi@bilkent.edu.tr

Or write to: State Enterprise "Research Institute of Microdevices" STC "Institute for Single Crystals" of NAS of Ukraine, 04136, Kiev, 3, Pivnichno-Syretska Str.



Infrastructure

IMD buildings has been designed to be a center for micro- and nanoelectronic devices fabrication. In this regard all facility is vibrational-resistant with all the necessary infrastructure such as electricity, water, gas, heat and ventilation lines. IMD manufacture-oriented complex consists of two main buildings: (1) technological building (three main floors plus three operation floors and basement level); (2) administrative building (seven floors with laboratories, offices, meeting and conference rooms) and supported building (two floors with laboratories). Since the establishment of IMD, the infrastructure has been developed to satisfy the needs in manufacture production of micro- and nanoelectronic devices mainly oriented for military and dual use applications.

Nowadays IMD possesses as multidisciplinary research and manufacture environment that should satisfy the needs of internal researchers, researchers from universities and institutions, companies from various disciplines inside Ukraine and neighboring countries. Due to difficult economical conditions in Ukraine IMD is needed upgrade of some infrastructure elements. Nevertheless with its ever expanding capabilities, IMD could provide the 21st century state-of-the-art technology to support the research and development activities. As equally importantly, the specialized instruments can be utilized with the guidance of highly qualified technical personnel. The novice users are accompanied by experienced IMD personnel in order to make the most of the time they spend at IMD facility. A list of the available instruments are given in this section. The details of each instrument can be viewed on our facility webpage. These days IMD administration, researchers and engineers partially spend time on renovation and modernisation of different types of equipment so that it can be used for achieving micro- and nanostructures, and devices with better performances. For utilizing our facility – kindly contact Directorate’s office.



Technological equipment

- | | | | |
|---|-----------|--|------------|
| ■ Metal organic chemical vapor deposition | | ■ Photolithography | |
| ■ Ion-implantation doping | (2 items) | ■ Spin coater | (5 items) |
| ■ Electron-beam evaporation | (2 items) | ■ Mask writer | |
| ■ Thermoresistive deposition | | ■ Mask aligner | |
| ■ Plasma-chemical films deposition | | ■ Plasma-chemical etching and treatment | (2 items) |
| ■ Magnetron sputtering | (4 items) | ■ Chemical-mechanical wafers polishing | |
| ■ Dielectric and metal films deposition | (3 items) | ■ Electro-sonic welding | (2 items) |
| ■ Doped and undoped films deposition | (3 items) | ■ Equipment for diamond grinding of wafers | |
| ■ Pulsed films and substrates annealing | | ■ Wafers and photoresists drying systems | (10 items) |
| ■ Low temperature films deposition | | ■ Equipment for preparation of grinding ball of semiconductor structures | |
| ■ Diffusion furnaces | (4 items) | ■ Wet bench | (5 items) |
| ■ Muffle-type furnace | | | |

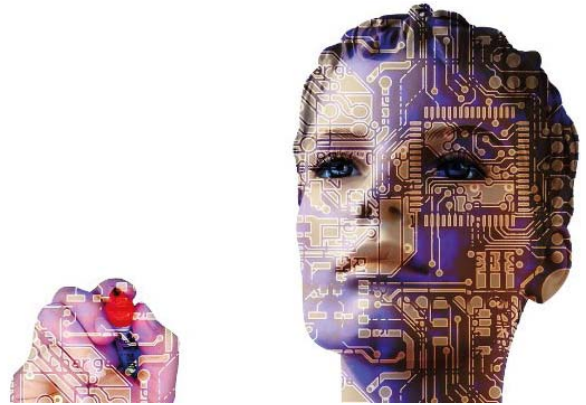
Diagnostics equipment

- | | |
|--|---|
| ■ Automatized system for microdefects and microimpurities control in semiconductors by deep levels spectroscopy (DLTS) | ■ Compact CCD Spectrometers Thorlabs |
| ■ Analysis of the electrical characteristics of IC and LIC elements | ■ Scanning Electron Microscope |
| ■ Precision control of electrical parameters of semiconductor structures | ■ Micro-profilometer |
| ■ Complex for measurements of electrical parameters of MDS structures | ■ Ellipsometry (2 items) |
| ■ Temperature-field characterization of semiconductor structures. | ■ Luxometer |
| ■ Surface resistance mapping of semiconductor wafers and process layers. | ■ Monochromator |
| | ■ Oscillograph (10 items) |
| | ■ High resolution optical microscope |
| | ■ Leak-detection equipment |
| | ■ Heat-cold system Tabaico |
| | ■ Control of the films and junction depth |
| | ■ Films thickness control |



Contribution to Industry & Academia

IMD fosters an environment promoting industry and academia partnership. Researchers at IMD have a strong ability to manage interdisciplinary projects and also meet the expectations of industrial partners. IMD aims to develop the scientific and technological capacity of SMEs and large organizations through joint projects and short term industrial contracts. IMD is ready to support researchers on their way to create spin-off companies based on the achievements received while working at IMD environment. Additionally, IMD infrastructure enables the companies to have access to the state-of-the-art equipment and the know-how for their specific needs.



As the need for value added products in Ukraine is increasing, IMD will serve to more people with its technological capacity and know-how. The necessity of Ukraine in high technological products pushes us further in increasing the number of our partners. In 2016, IMD has also invested a lot of time to share information about our micro- & nanotechnological center both in Ukraine and abroad so that more researchers, companies, and academia representatives can contact us for further useful collaboration.

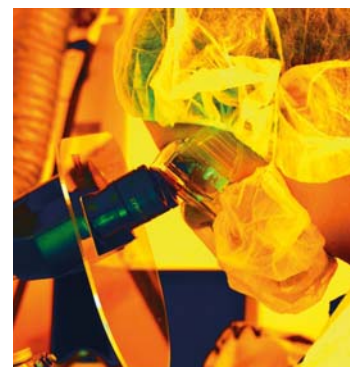
PATENTS, ARTICLES AND CONFERENCE ABSTRACTS

IMD researchers have achieved 1 patent, published 18 Articles in impact factor journals and got accepted 32 Abstracts that have been presented on the International and Ukrainian conferences during 2016.



Dept. of technological & analitical research

1. **The influence of high-energy electrons (2 MeV) on electrical properties of MIS structures and solar cells.**
 - The complex study on the effect of electrons with 2 MeV energy influence (the doses order – 1×10^{15} 1/cm²) on the electrical parameters of MIS structures (structure test integrated circuits) and electrical characteristics of serial solar panels was performed. (The study was carried out jointly with the Institute for Nuclear Research of NASU).
2. **Analytical and experimental study of new optoelectronic device (light emitting diode) based on multicomponent solid solutions of aluminum, gallium, indium nitride (AlN, GaN, InN).**
3. **Development of new methods for investigation of semiconductor structures.**
 - We developed a new method for determining the surface potential in the semiconductor through the use of puls-nonmodulated-volt-charging characteristics of MIS structures. The method improves the accuracy of main electrical parameters detection for MIS structures, dopant concentration profile, the bulk lifetime of minore carriers etc.
4. **Investigation of the effect of long-range interaction at low energy ion irradiation of semiconductor structures on silicon.**
 - The discovered effect of long-range interaction is promising for practical use in microelectronics to improve the functionality of high-tech products at different stages of their fabrication.
5. **We investigated the influence of low-energy ion-plasma etching of the back side silicon wafers on electro-physical properties of MIS structures**
 - Current method is promising for deliberate action on the parameters of semiconductor devices.
6. **Quality verification of technological processes and diagnostics equipment testing for checking the accuracy of IMD facility.**
7. **Production technology of experimental structures for far IR range photodiodes**
 - Experimental batch of technological structures for far IR range photodiodes based on chrome-on-sapphire and chrome on quartz structures.



Dr. V. Popov



Dr. V. Osinsky



Mr. V. Ryzhkov



Mr. V. Glotov



Mrs. N. Lyahova



Mr. M. Onachenko



Dr. P. Deminskyi



Dept. of Nuclear-Physical & Radiation Instruments

1. Development of a coordinate-sensitive detector for diffractometry.

- We designed a coordinate-sensitive detector for diffractometry. It records the distribution in space and time the intensity of X-ray photons scattered in the studied samples. The detector is intended for direct registration of X-ray radiation with energies in the range 6–20 keV. From the perspective of developed detector design the layout of the new device for high-speed X-ray radiography was made. It allows to increase the speed of analysis for orders of magnitude more and extend X-ray analysis. The detector can also be used to record high-energy charged particles in high energy physics and nuclear physics. (Study was performed in close collaboration with Institute for Problems in Materials Science, NASU).



The achieved results of detector tests indicate possibility to implement microstrip-based silicon detectors, both for conventional diffractometry and for high-speed diffractometry. With such detectors, the total analysis speed reduced from hours to fractions of a second, which makes it possible to use it as an in-situ characterisation device to observe the structural changes on examine samples in on-line mode.

2. Development of a silicon p-i-n photodetector

- We developed a new generation silicon p-i-n photodetector with improved monochromatic sensitivity in the near infrared region at a wavelength $\lambda=1,06 \mu\text{m}$ for anti-tank missiles direction laser systems. Investigation of electro-physical characteristics of four-sectoral p-i-n photodetectors shown they meet the requirements for devices designed for high-precision direction laser systems and having an increased sensitivity to monochromatic wavelength at $\lambda=1,06 \mu\text{m}$.

3. Development of solid-state silicon linear and matrix diode detectors.

- We developed solid-state matrix and linear silicon diode detectors for monitoring the high energy beam in radiotherapy.

4. Engineering & assambling development for photosensitive capsules of IP photodiodes for military purposes

- Testing of assembly technology of IR photodiode photosensitive capsules for military purposes. IR photodiode photosensitive capsules capable to withstand 300 cycles of cooling in the range 20 °C–196 °C for infrared navigation system of missiles for man-portable air defense system (MANPADS). Technological process, prototypes and photo-electric models were developed; photodiode assemblies to determine the quality of manufacturing operations collection devices was tested.



Dr. V. Perevertailo



Dr. V. Zhora



Mrs. V. Grunianska



Mr. V. Perevertailo



Mr. L. Tarasenko



Mrs. V. Magurova



Dept. of Integrated Circuits

Main directions of scientific and production activities are concentrated mainly on research and development of:

- Integrated circuits;
- Photomasks;
- Flexible substrates (aluminium-polyimid) for micro- and nano(opto) electronic applications.

The department has accumulated the necessary scientific and technical capabilities and experience for:

- development and manufacture of photomasks;
- compiling chips;
- measuring electrical parameters of IC;
- development and research of microwave monolithic BIC;
- manufacturing experimental models of microelectronic coordinate-sensitive detectors for charged particles spectroscopy;
- manufacturing big integrated circuit (BIC) based on CMOS technology;
- development of a silicon CMOS topology of integrated circuit (IC).

During 2016 researchers of our department performed:

1. The development and manufacturing of microelectronic coordinate high-sensitive detectors for elemental analysis of substances (atomic concentration down to ~0.0006%).
2. Study on development of next generation microelectronic coordinate high-sensitive detectors with high-speed and broad spectral range analysis.
3. Development and production of devices for spectroscopy that can be used in such fields as mining, metallurgy, food, chemical, pharmaceutical sectors, nuclear energy, space research, for rocket fuel production, explosives, nanomaterials development.



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Partners from Industry & Academia



agnitron
technology



UKROBORONPROM
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🌐 **VM Glushkov Institute of Cybernetics of NASU**

🌐 **Igor Sikorsky Kiev Polytechnic Institute**

🌐 **Vinnitsa National Technical University**

🌐 **Kiev Aviation University**

🌐 **Taras Shevchenko National University of Kyiv**

🌐 **Vinnitsa National Technical University**

🌐 **IEEE Ukraine Section**

🌐 **etc.**

Ukrainian scientists worldwide

- | | |
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| 🇹🇷 Dr. Ihor Pavlov | (Turkey) |
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| 🇺🇸 Dr. Konstantin Pokhodnia | (USA) |
| 🇺🇸 Dr. Andrey Osinsky | (USA) |



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The First Annual Report of IMD in English
The First time IMD website & our research are available for broad audience

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