LABORATORY OF SEMICONDUCTING AND RADIATION TECHNOLOGIES

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Scientific Direction: Ion-implantation nanosized metals with the improved mechanical properties

Semiconducting and Radiation Technologies Lab of Ilia Vekua Sukhumi Institute of Physics and Technology (SIPT) was set up in 2006 year. Works conducted on ion-implantation in Tbilisi appear logical continuation of the years accumulated experience started from 1960 in Sukhumi. The Lab fully corresponds to the advanced stage of the ion implantation development. Current works basically refer to nano materials and nanotechnologies. In specific, fabricating and researching metastable, unstable, nanocrystalline ion-implanted metallic and semiconductor materials-items with the improved properties under different conditions from the requirements of thermo-dynamic non-equilibrium by radiation technologies. The vitality of the works is conditioned by growing demand on semiconducting micro-nano electronic, optoelectronic, and new class construction and metal materials with the improved mechanical properties. The Lab envisages demands on the converters allowing solar and thermal radiation converting into electric energy applying photoelectric and thermoelectric methods. An innovative technology - ion-implantation is used to obtain new and modified materials. Radiation technology used for the materials modification is based on the general theory of accelerated particles and solid body interaction. Radiation processes, nano-physical phenomena, irradiation conditions during ion radiation, determine effects of materials improvement and degradation, so called radiation resistance. Scientific value of current works refer to further development of radioactive materials science and technologies; expansion of the ion-implantation materials class and their possible application fields. Fabrication ion-implanted new materials with the improved parameters occur dramatically important. At present, radiation modified semiconducting and metal materials are not produced in Georgia.

Obtained Results are presented below:

- Bombarding particles radiation parameters are calculated for determining irradiation conditions and materials properties impact. Computer calculations are conducted by SRIM 2012 and TRIM programs;
- Samples precision cutting, mechanic and electric chemical grinding-polishing method is developed for obtaining minimal violation surface layers and roughness crystal, parallel semiconductor and metal material samples. 4.5-17.5 nm Roughness samples are obtained using automated cutting Saw EQ-SVJ-200 (USA), precision automated grinding-polishing UNIPOL-802 (Germany) and M-PREP 3 (USA) machines purchased by the Institute.
- Radiation technology processes are developed to obtain modified materials.
- Materials ultra-micro-hardness is studied at the state of the art SHIMADZU DUN-213S dynamic ultramicrohardness device purchased by the Institute.
- Mtarials ware-resistance is determined by the abrasive ware method on grinding-polishing machine M-PREP 3.
- Molybdenum, nibiumis, AISI 310S, 440 C type steel, ball bearings 440 C-balls nitrogen, carbon ions and by their subsequent irradiation obtained new wear-resistant ion-implanted construction materials (nanosized 2.2-3.8 times improved and 3.5-5.7 times increased ware-resistant) are obtained.
- Si-Ge thermoelectrical generator module (TEGM) parameters' degradation mechanism is defined; TEG's resource capacity, fabrication and exploitation recommendations are ready.
- Crystalline implantation with boron Carbon ions at the temperatures 300-900 K is synthesized β-rhombohedral boron carbide, which is not allowed without ion bombardment.
- 200-300 nm structures with the increased electrical conduction by 2-3 levels are created from silicon and phosphorus implantation with β- boron ions at room temperature.
- 162 mm Diameter spherical nanogrinding device is fabricated for nanosize modified materials metallographic studies.

Neutrons Semiconducting Implantation Sensor

Works on fabricating high efficiency original neutron flow counter-sensor provided with miniature, ion-implantation, microprocessor measurements are underway to ensure nuclear and radiation safety control.

Scientific Projects:

The Lab employees simultaneously perform planned themes and one Partnership and National Foundation project; participated in the performance of the three international projects. Currently, the Lab implements a National Science Foundation project:

1. Project GNSF №AR/1 6 7/3–121/14. Development of Ion-Implanted materials with Improved Mechanical Features for Manufacturing Items with Increased operation Parametres. 2015 – 2017.
2. Project GNSF №CF/72/11-811/15. International Conference Advanced Materials and Technologies (ICAMT). 2015.
3. International Partner Project STCU P-466 (Brookhaven National Laboratory USA, with the participation of National Science Centre "Khakiv Institute of Physics and Technology".2012-2014.
4. Project CIS/10/0005/CNTR. Organization of Manufacture of Natural Gas Odorizes BRITISH - CLOSED NUCLEAR CENTRES PROGRAMME (CNCP). 2010 - 2012.
5. . Project GNSF/ST08/7-476, Ion-implanted New Materials for Mikro and Nanotechnology 2009-2011.
6. Project STCU Gr-3997(j). Development & Investigation of Bulk Semiconductor & Epitaxial Structures on the Base SiGe Alloys.2008-2010

Staff:

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