Beam request at Bucharest TANDEM

Experiment Title:

The influence of protons and alpha particles irradiation on photovoltaic properties from solar cells used in space applications – stage II

Experiment Responsible:

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Short presentation of the scientific project:

- degradation of A_2B_6 semiconducting compounds thin films due to protons and alpha particles irradiation stress;
- identification of radiation effects on the structural, electrical and optical properties of ZnS/CdS/CdTe photovoltaic structures;
- finding out the posibilities of increasing photovoltaic cells lifetime used in space applications.

Description of proposal:

The power conversion efficiency of the solar cells depends on the structural, electrical and optical properties of the semiconducting materials used in their fabrication, the design of the cell structures, all these being in a strong correlation with the physical and chemical properties of the operating medium. That is why the research activities of the scientific community in the field are oriented on the preparation and characterization of new semiconducting materials with specific electrical and optical properties and the design technology of the cells, leading to more efficient and low price solar cells. These goals generated the increased interest in the study of A2-B6 semiconducting compounds thin films, especially ZnS, CdS, CdTe etc. As a results of their adequate optical gap (3.6eV -2.4 eV -1.45 eV), high absorption and high primary quantum efficiency on whole solar spectrum, respectively, good stability, the heterojunctions based on CdS, CdTe thin films are promising materials for high efficiency (~17%) solar cells. The photovoltaic cells based on Zns, CdS, CdTe thin films could be used in space technologies due to their physical and chemical stability, low cost of the cells and very important due to their low mass, essentially property for space applications. Recent results obtained in our group shows that such structures demonstrate a good endurance to irradiation with energetic protons [1-3] and electrons. It is worth mentioning that, for example, geostationary orbit (GEO) satellites experience irradiation with protons with energies of about 10 MeV, up to 10^{10} cm^{-2} integral annual doses. Also GEO satellites are subjected to high energy cosmic radiation, including alpha particles. Efforts will be made to improve the quality of CdS/CdTe interface and the charge collection at electrodes.

Taking into account the above ipothesis, the goals of the present project are the prepared cells before and after protons and aplha particles irradiation to understand the effect

of the ionizing radiations on their parameters, taking into account the fact that, being used in space application, they will operate in high level of ionizing radiations.

Nevertheless we must underline again the importance of these studies to foresee the behavior of the solar cells running in high degree of cosmic radiations. Knowing the structure of cosmic radiation (87% protons, 12% α rays, 1% heavy nucleus,etc) we propose to irradiate the prepared structures with protons and alpha particles on different energies and fluencies and comparing their structural, electrical and optical properties before and after irradiation to identify the induced changes. Here it must be pointed out that the equivalent damage due to alpha particles has been found to be one and three orders of magnitude larger than for protons and electrons respectively, due to differences in their effective mass and the probability of collision for the formation of lattice defects. The radiation tests with alpha particles have been often used because they introduce more primary and cascade complex defects and accelerate the devices degradation. All these studies will allow identifying the causes of the relatively short lifetime of the solar cells used in space applications.

Bibliografie:

[1]. C. Tazlaoanu, L. Ion, I. Enculescu, M. Sima, M. Enculescu, E. Matei, R. Neumann, R. Bazavan, D. Bazavan, S. Antohe, Physica E 40, 2504 (2008).

[2]. L. Ion, I. Enculescu, S. Iftimie, V. Ghenescu, C. Tazlaoanu, C. Besleaga, T.L. Mitran, V.A. Antohe, M.M. Gugiu, S. Antohe, Chalcogenide Letters 7, 521 (2010).

[3]. S. Antohe, V. Ruxandra, H. Alexandru, J. Cryst. Growth. 237, 1559 (2002).

The Benefit:

The proposal is targeting an important research field, namely the photovoltaic conversion in the context of applications to space technology. The results are important for determining the way that cosmic radiation (with energetic protons representing 87% and alpha particles representing 12%, respectively of its total flux) alterates the performance of photovoltaic elements used as energy source. All this efforts are in agreement with European Space Agency programs, aiming at identification and development of techonolies or equipments for future space missions/applications.

ISI Results:

1. S. ANTOHE, V. GHENESCU, S. IFTIMIE, A. RADU, O. TOMA L. ION, *"EFFECTS OF ALPHA PARTICLES IRRADIATION ON THE PHOTOELECTRICALPROPERTIES OF CdS/CdTe HETEROJUNCTIONS"*, **Digest Journal of Nanomaterials and Biostructures Vol. 7, No. 3, 2012, p. 941 - 946**
2. O. TOMA, S. IFTIMIE, C. BESLEAGA, T. L. MITRAN, V. GHENESCU, O. PORUMB, A. TODERAS, M. RADU, L. ION, S. ANTOHE, *"NEW INVESTIGATIONS APPLIED ON CADMIUM SULFIDE THIN FILMS FOR*

PHOTOVOLTAIC APPLICATIONS", **Chalcogenide Letters Vol. 8, No. 12, December 2011, p. 747 – 756**

3. M. RADU, V. GHENESCU, I. STAN, L. ION, C. BESLEAGA, A. NICOLAEV, T.L. MITRAN, C. TAZLAOANU, A. RADU, O. PORUMB, M. GHENESCU, M.M. GUGIU, S. ANTOHE, *„PHOTOVOLTAIC PROPERTIES OF THE CdS/CdTe HETEROJUNCTION SOLAR CELLS BEFORE AND AFTER PROTON IRRADIATION"* **Chalcogenide Letters Vol. 8, No. 8, August 2011, p. 477 – 485**
4. M. RADU, Veta GHENESCU, I. STAN, L. ION, Cristina BESLEAGA, Adela NICOLAEV, T.L. MITRAN, C. TAZLAOANU, A. RADU, Oana PORUMB, M.M. GUGIU, S. ANTOHE**, „***Photovoltaic properties of the CdS/CdTe heterojunction solar cells before and after proton irradiation"* **EMRS - Spring Meeting, Nice, Franta, 2011**
5. L. ION, V. GHENESCU, S. IFTIMIE, V. A. ANTOHE, A. RADU, M. GUGIU, G. VELISA, O. PORUMB, S. ANTOHE, *„Temperature dependent resistivity and Hall effect in proton irradiated CdS thin films"*, **Journal of Optoelectronics and Advanced Materials – Rapid Communications, Vol. 4, Issue. 8, 14-1117, 2010**
6. L. ION, I. ENCULESCU, SORINA IFTIMIE, VETA GHENESCU, C. TAZLAOANU, CRISTINA BESLEAGA, T.L. MITRAN, V. A. ANTOHE, M.M. GUGIU, S. ANTOHE, *„EFFECTS OF PROTON IRRADIATION ON THE SPECTRAL PERFORMANCE OF PHOTOVOLTAIC CELLS BASED ON CdS/CdTe THIN FILMS"*, **Chalcogenide Letters, Vol. 7, No. 8, 521-530, 2010,**

Beam time request (unit = 8 hours): 4 zile (2 zile pentru protoni, 2 zile pentru particule alpha),

Desired Period: February – April 2013

Desired beam properties:

- protoni, **Energy (MeV):** different energy (1 – 3) MeV, **Intensity (p/nnA):** 10
- particule alpha, **Energy (MeV):** different energy (1 – 5) MeV, **Intensity (p/nnA):** 10

Vacumm requests: 10^{-6}

Special requirements for detectors, electronics, aquisition system: -

Minimal information needed for radiological risk evaluation:

a) **Source activity:** nu e cazul
b) **Use of open source:** -
c) **Estimate of the residual activity as result of radiation:** sub limita fondului natural de radiatii
d) **Means of storage/transportation for iradiated targets: -**