

**09.06.2011**

**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

**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 ITO/CdS/CdTe/Metal photovoltaic cells;
- finding out the possibilities 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 CdS, CdTe etc. As a results of their adequate optical gap (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 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. Taking into account the above ipohthesis, the goals of the present project are the prepared cells before and after proton 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% 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.

### **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) alters the performance of photovoltaic elements used as energy source.

### **ISI Results:**

1. 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**
2. 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**
3. 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,**
4. Sorina IFTIMIE, Veta GHENESCU, Cristina BESLEAGA, T.L. MITRAN, Oana PORUMB, V. A. ANTOHE, M. RADU, C. TAZLAOANU, A. RADU, L. ION, S. Antohe “*Photovoltaic cells based on A2-B6 compounds used in space Applications*” **International Conference of Aerospace Sciences „AEROSPATIAL 2010, Bucharest, 20-21 October, 2010- Proceedings, S4.2.1, 12 pags- ISSN 2067-8622**
5. Veta Ghenescu, L. Ion, G. Velisa, Sorina Iftimie, M. Ghenescu, Oana PORUMB, I. STAN, M. Gugiu, H. ALEXANDRU, S. Antohe „*Transport mechanisms in CdS thin films before and after irradiation with high energy protons*”, **11<sup>th</sup> INTERNATIONAL BALKAN WORKSHOP ON APPLIED PHYSICS, 7 – 9 JULY, CONSTANTA, ROMANIA, 2010, oral presentation**
6. Veta Ghenescu, L. Ion, M. Ghenescu, M. Rusu, M. Gugiu, G. Velisa, Oana Porumb, S. Antohe, “*Effects of proton irradiation on structural and optical properties of CdS*

- thin films used in photovoltaic applications*”, **Journal of Optoelectronics and Advanced Materials – Rapid Communications, Vol. 3, Issue 10, 1023-1026, 2009**
7. Rosemary BAZAVAN, Oana GHENESCU, M. GHENESCU, Dora CRISAN, A. RADU, L. ION, S. ANTOHE, “*Effects of proton irradiation on CdTe thin films used in photovoltaic applications*” **Journal of Optoelectronics and Advanced Materials, Vol. 10, p. 3048-3051, 2008**

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

**Desired Period:** nov. 2011 sau feb. 2012

**Desired beam properties:**

- protoni, **Energy (MeV): 3, Intensity (p/nA): 10**
- particule alpha, **Energy (MeV): 5, Intensity (p/nA): 10**

**Vacuum requests:**  $10^{-6}$

**Special requirements for detectors, electronics, acquisition 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 irradiated targets:** -