Advanced microcrystalline absorber solar cell for space applications

Summary

This PhD project is aiming at exploring the properties of novel PV absorbers that are suitable for space applications and can be used in microcrystalline solar cell. We are aiming the materials that can be harvest from the lunar regolith or mars regolith. Materials that will be selected have to fulfil the criteria set for the solar cell absorber material and according to the theoretical calculations should enable to achieve high solar energy conversion efficiencies and can be produce in situ from the source of planetary/moon regolith. In the frame of this PhD project, FeS2, Si single crystals and polycrystalline powders will be synthesized at high temperatures enabling detailed analysis of the properties of high quality material compared to thin films deposited at low temperatures. Also thin film NiO deposition will be studied with wet chemical methods. Detailed characterization of the structural, optical and electrical properties of these materials will be conducted.

Research field:	Chemical, materials and energy technology
Supervisor:	Taavi Raadik
Availability:	This position is available.
Offered by:	School of Engineering Department of Materials and Environmental Technology
Application deadline:	Applications are accepted between January 02, 2023 00:00 and January 22, 2023 23:59 (Europe/Zurich)

Description

Solar photovoltaics is a major energy source, in the inner Solar System, for powering satellites or future Lunar/Mars outposts. As the space race to the Moon and Mars has been started by the national space agencies such as ESA, NASA, CNSA and privet companies like Space-X, Lockheed Martin Space etc. there is a huge need for any kind of revolutionary and state of the art technologies that can help humans to survive in such unfriendly environment that greets us on Moon and Mars. Additionally, to the shelter for the inhabitants, one of the most important issues in establishing an outpost will be the availability of energy sources. Solar panels is one of the most promising options due to the fact, if we focus on the moon, that some areas on Lunar South pole, that is selected as a moon base location, are constantly illuminated by sun. This would enable to constant production of electricity from sunlight. One possibility is to bring the solar panels from Earth or more perspective solution would be to find a way to produce in situ solar panels on Moon or Mars. This requires development of a photovoltaic (PV) technology that is cheap, requiring a limited amount of terrestrial material and that is easily implementable. One promising solution is Monograin layer solar cell technology. Scientists from TalTech have been working on this technology for almost two decades, having state of the art knowledge.

This PhD project involves two laboratories. Material synthesis is conducted under the supervision of staff members of the Laboratory of Photovoltaic Materials Research, this lab has been working on the synthesis of single or polycrystalline semiconductor compounds and development of monograin layer technology for PV applications. The project as a whole is supervised by Dr. Taavi Raadik from Laboratory of Optoelectronic Materials Physics responsible for the characterization of the developed materials and devices based on them. The expected outcome of this PhD work is comprehensive overview of the structural and optoelectronic properties of high quality novel absorbers of solar cells for space application.

The PhD student is expected to perform a systematic study of the structural, optical and electronic properties of proposed absorber materials (FeS_2 and its derivates) single crystals and NiO polycrystals by using various characterization techniques including Raman scattering, XRD studies, SEM studies, UV-Vis spectroscopy, photoluminescence (PL) spectroscopy, PL imaging and measurement of electrical properties such as resistivity/conductivity etc. The PhD student is expected to plan the synthesis of the materials in terms of synthesis conditions and material composition. The synthesis itself will be conducted will be conducted at the Laboratory of Photovoltaic Materials Research under the supervision of Dr. Marit Kauk-Kuusik.

Requirements for doctoral student: candidate must have a Master degree in Materials Engineering or Physics or equivalent, and hold previous experience in research activities, preferentially in the field of semiconductor materi-

als physics or chemistry, also good knowledge about space environment and experience working in space industry/agency is a good asset. High level of English and very good communication and writing skills are required. Candidate should show a problem-solving attitude and a strong desire to stay up-to-date with recent advancements in the field and be able to work independently.

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