SCIENTIFIC TRACKS | **DAY 2** *JOURNAL OF NANOMATERIALS & MOLECULAR NANOTECHNOLOGY, VOLUME 8 | DOI: 10.4172/2324-8777-C2-059*

Electrochemical synthesis of photoactive carbon-carbide structures on silicon

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Carbon-silicon compositions are promising to improve light harvesting performance of silicon-based solar cells. Silicon modification by carbon species could increase light absorbance and accelerate photoelectron generation. Procedures of chemical or physical vapor deposition as well as various etchings are typically used to improve antireflection performance of silicon surface. Most of these techniques, however, are not cost effective and also include hazardous reactants. We demonstrate an environmentally friendly electrochemical method of silicon surface modification by a carbon-carbide system in molten calcium chloride. Silicon-carbon-carbide compositions were obtained by polarizing silicon-silica precursor in molten calcium chloride electrolyte using a graphite anode. A reaction scheme is discussed, which includes release of oxygen from silica, its interaction with a graphite electrode and reduction of carbon dioxide by calcium metal. Structure and composition of the structures have been studied by EDX, XRD, and XPS. Semiconductor properties of the structures have been studied by Mott-Schottky characteristics, EIS and photo electrochemistry. High photoactivity of the structures is demonstrated. The surfaces absorbed over 90% of white light in a broad region of wavelengths from 400 nm to 1100 nm. The proposed method offers new opportunities for production of carbon-modified silicon surfaces with superior antireflection and protective properties for solar devices, photoelectrodes, sensors and catalytic supports.

Biography

Professor Eimutis Juzeliiūnas is the principal research associate at the Centre for Physical Sciences and Technology in Vilnius, Lithuania. His recent research areas include silicon electrochemistry for energy applications, environmental and microbiological degradation of metallic materials, PVD alloys, molten salt electrochemistry. The research leading to these results has received funding from the European Commission 7th Framework Programme under grant agreement PIOF-GA-300501.

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