4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

IR light harvesting with silicon microspheres - application to photovoltaic devices

Moisés Garín[1*], Roberto Fenollosa[2,3], Lei Shi, Ramón Alcubilla[1], Lluís F. Marsal[4], and Francisco Meseguer[2,3]

[1]*Dept. d'Enginyeria Electrònica, Universitat Politècnica de Catalunya. 08034 Barcelona, Spain*
[2]*Unidad Asociada ICMM/CSIC-UPV, Universidad Politécnica de Valencia, 46022, Valencia, Spain*
[3]*Instituto de Ciencia de Materiales de Madrid CSIC, Madrid, 28049, Spain*
[4]*Dept. d'Enginyeria Electrònica, Electrica I Automàtica. Universitat Rovira i Virgili. 43007 Tarragona, Spain*

Accepted for publication on the 26th of January 2015

Single-junction photovoltaic devices suffer from intrinsic obstacles limiting their efficiency to a top value dictated by the well-known Shockley–Queisser (SQ) limit [1]. The most fundamental limitation is given by the energy bandgap of the semiconductor, which determines the minimum energy of photons that can be converted into electron-hole pairs. In the case of silicon a large percentage of infrared sunlight, with energy value below the fundamental absorption edge of silicon, is still useless. The development of photodiode devices on micro and nanophotonic structures has opened new possibilities over the standard technology. The impinging light is strongly confined inside those photonic structures, enhancing the optical absorption and photocarrier generation, as it has been reported for planar optical cavities and, more recently, for nanowire resonators [2,3]. Here we show the first example of a photodiode developed on a micrometer-size silicon spherical cavity whose photocurrent shows the Mie modes of a classical spherical resonator [4]. The long dwell time of resonating photons enhances the absorption efficiency of photons. As a result, the photocurrent response shows a rich spectra with plenty of high-*Q* resonant peaks in a similar manner as the scattering spectra of the high-order whispering gallery modes (WGMs) of spherical microcavities. Also, as a consequence of the enhanced resonant absorption, the photocurrent response extends far beyond the absorption edge of crystalline silicon [4]. It opens the door for developing a new generation of silicon solar cells and photodetectors that may harvest infrared light more efficiently than current silicon based photovoltaic devices.

Keywords:

Keywords: silicon; microspheres; Mie resonator; photodiode; infrared.