SOLAR QUEST

SEMINAR ANNOUNCEMENT

Dr. Stanko Tomić

Reader in Physics, Joule Physics Laboratory
University of Salford, Manchester, UK

MODELLING OF VERTICAL AND IN-PLANE QUANTUM DOT ARRAYS FOR HIGH EFFICIENT SOLAR CELLS

DATE: Monday, October 22, 2012
TIME: 14:00 am-16:00 pm
PLACE: Seminar Room A-502
CCR Building, 5F

ABSTRACT

Vertically or in-plane arranged semiconductor quantum dot (QD) arrays emerged recently as promising structures for the high efficient solar cell devices. In this work, we have employed a multi-band **k·p** theory combined with the periodic boundary conditions to calculate the electronic band structures, optical and dynamic processes of InAs/GaAs QD arrays and compare them to experimental results. For typical InAs/GaAs QD arrays with vertical coupling, we have estimated energy gaps between the valence band (VB) and intermediate band (IB) of 1.2 eV and between IB and conduction band (CB) of 0.124 eV. The predicted efficiency of such IBSC in the radiative limit is 39%. Our predictions suggest that the most promising design for an IB material that will exhibit its own quasi-Fermi level is to employ small InAs/GaAs QDs (~6-10 nm QD lateral size). With appropriate design of the QD array structural parameters: (1) the regions of pure zero DOS between IB and the rest of the CB states are identified, and (2) the strong optically allowed excitation between IB and CB exists. Analysis of various radiative and nonradiative processes indicates that most detrimental effect on transport properties originate from the non-radiative Auger electron cooling process (2 ps) between IB and CB, that is 3 orders of magnitude faster that any other relaxation process in the IBSC. We have shown that with appropriate band structure engineering, it is possible to place the intraband Auger electron cooling decay in the ns range. Recent theoretical studies focus on examination of the realistic type II structures that can suppress Auger electron cooling process like those containing GaAsSb buffer region underneath QDs.

Solar Quest Host: Prof. Yoshitaka Okada, ext. 56501.

Univ. Tokyo RCAST