Investigation of thermalization and thermoelectric effects in multi-quantum well structures

Hamidreza Esmaielpour[1], Daniel Suchet[2], Maxime Giteau[3], Daniel Ory[4], Laurent Lombez[5], and Jean-François Guillemoles[1]

[1] *CNRS-Institut Photovoltaique d'Ile de France (IPVF), UMR 9006, Palaiseau, France.*

[2] *CNRS, Ecole Polytechnique, Institut Photovoltaïque d'Ile-de-France UMR 9006, Palaiseau, France.*

[3] *Research Center for Advanced Science and Technology, University of Tokyo, Tokyo, Japan.*

[4] *Électricité de France (EDF) R&D, Palaiseau, France.*

[5] *Laboratoire de Physique et Chimie des Nano-objets (LPCNO-INSA), Toulouse, France.*

Hot carrier solar cells are one type of third-generation photovoltaic devices, which aim to increase the power conversion efficiency beyond the Shockley-Queisser limit (33% for single junction solar cells under a one sun condition). Thermalization of hot carriers through interacting with phonons in solar cells is one of the main loss mechanisms, which reduces the efficiency of solar cells. Therefore, the suppression of thermalization mechanisms and the rapid extraction of hot carriers can lead to an improvement in the efficiency of solar cells that are the basis of hot carrier solar cells. Quantum-well (QW) structures are one of the promising designs for hot carrier absorbers, which have shown robust hot carrier effects in thin-film materials at accessible solar concentrations (< 1000 suns). In addition, in such planar structures, the diffusion of hot carriers due to a gradient of temperature and charge density across the sample induces a thermoelectric effect, which has impacts on the thermalization and the extraction of the hot carriers.

Here, we present our results on hot carrier thermalization and thermoelectric effects for InAs-based multi-QW hot carrier absorbers. Hyperspectral luminescence imaging under continuous-wave photoluminescence (PL) spectroscopy at various excitation powers and lattice temperatures is performed to investigate the properties of hot carriers in the QW structures. The accurate determination of thermodynamic properties of hot carriers, such as temperature and quasi-Fermi level splitting, is performed by fitting the emitted PL spectrum with the generalized Planck law (full PL spectrum fit) and taking into account the effects of band-filling and occupation of excited states.