The effects of band filling and density of states of nanostructure materials in determination of hot carrier temperature

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Hot carrier solar cells are one type of third generation photovoltaic devices, which have been proposed to increase the power conversion efficiency beyond the Shockley-Queisser limit (%33). In this type of solar cells the excess kinetic energy of hot carriers is converted to useful electricity rather than being lost through thermalization mechanisms. Designing efficient hot carrier absorbers to inhibit thermalization loss is challenging, however, nanostructure materials, such as quantum well (QW) structures, have shown evidences of robust hot carrier distributions at room temperature and relatively low excitation powers. [1-4] Determination of carrier temperature in hot carrier absorbers is essential to investigate the properties of photo-generated hot carriers and to evaluate the performance of the absorbers in suppression of thermalization mechanisms. One practical technique to determine carrier temperature is steady state photoluminescence (PL) spectroscopy. Through this contact-less measurement, it is possible to provide rich information about the behavior of hot carriers in the system. Determination of carrier temperature in nanostructure materials utilizing the generalized Planck's radiation law requires a careful analysis due to complexity imposed by quantum confinements in such structures. [5]

We present our results in advanced PL spectroscopy of InGaAs QW structures considering the effects of density of states and quantized energy levels in determination of carrier temperature. [1,5] We will also show how different extracted carrier temperatures will be without considering these effects. In addition, we will discuss our results in determination of thermalization coefficient of QW structures as an empirical technique to evaluate the performance of hot carrier absorbers in suppression of phonon mediated thermalization mechanisms.

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