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Study of LO-phonon decay in semiconductors for hot carrier solar cell HUGO LEVARD, JULIEN VIDAL, SANA LARIBI, JEAN-FRANÇOIS GUILLEMOLES, IRDEP (Institute for Research and Development on Photovoltaic Energy) — Knowledge of phonon decay is of crucial importance when studying basic properties of semiconductors, since they are closely related to Raman linewidth and non-equilibrium-hot-carriers cooling. The latter indeed cools down to the bottom of the conduction band within a picosecond range because of electron-phonon interaction. The eventual emitted hot phonons then decay in few picoseconds. The hot carriers cooling can be slowed down by considering the decay rate dependence of phonon on conservation rules, whose tuning may reduce the allowed two-phonon final states density. This is of direct interest for the third generation photovoltaic devices that are Hot Carrier Solar Cells (HCSC), in which the photoexcited carriers are extracted at an energy higher than thermal equilibrium. One of the HCSC main challenges then is to find an absorber material in which the hot phonons has a relaxation time longer than the carriers cooling time, so that we can expect the electron to "reabsorb" a phonon, slowing down the electronic cooling. HCSC yield is ultimately limited by LO phonon decay, though. In this work, we present theoretical results obtained from ab initio calculations of phonon lifetime in III-V and IV-IV semiconductors through a three-phonon process. Common approximations in the literature are questioned. In particular, we show that the usual "zone-center approximation" is not valid in some specific semiconductors. The analysis allows to correctly investigate phonon decay mechanisms in bulk and nanostructured materials.

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