O.31 Ultrafast dynamics of photoexcited carriers in bulk semiconductors and in accumulation layer: energy loss rate and screening effects

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Electron-phonon coupling determines the relaxation dynamics of photoexcited carriers. A computational method based on density functional theory and on interpolation of the electron-phonon matrix elements in Wannier space allowed to successfully interpret the dynamics of photoexcited electron relaxation in several semiconductors, such as GaAs, Si, InSe, in good agreement with two-photon photoemission experiments [1,2,4,5].

For photoexcited carriers, one can identify two distinct relaxation regimes, both due to the electron-phonon scattering: one is related to the loss of the initial momentum, and the other to the energy transfer from electrons to phonons [1,2]. For highly excited electrons, the relaxation times related to the loss of the initial momentum can be as fast as few femtoseconds, and often unmeasurable. In those cases, only the relaxation times related to the energy transfer from electrons to phonons can be measured experimentally [1,4,5].

In this work, we will present our recent results, both experimental and theoretical, on photoexcited electron relaxation in silicon. Numerous additional experiments were performed with respect to the previous experimental work of [3], and a new interpretation of the measured relaxation times is provided [4]. Moreover, we will discuss the temperature dependence of the relaxation times related to the energy transfer in silicon, and the roles of different scattering channels.

Then, we will present our results on the photoexcited electron relaxation in InSe. InSe is a quasi-2D material which was shown recently to have potential interest for optoelectronics. In this work, we will discuss our new results on the relaxation dynamics and screening of the electron-phonon interaction in doped InSe [5].

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