Electronic Mobility in a Periodic Superlattice of InSb Quantum Dots

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Quantum dots (QDs) are gaining attention for their potential use in various technological areas such as in health [1], computing [2], or electronic devices [3]. In this last field, the highly configurable features of QDs, such as energy levels and absorption spectrum via QD size and passivation have interesting potential applications. With colloidal QDs there is also a high monodispersion in fabrication and closed packing, which leads to the possibility of high interaction between these building blocks. This could lead to the formation of a periodic superlattice which would lead to the existence of energy minibands as it happens with atomic lattices in semiconductors.

We present an application of our technique [4] for calculating the band structure and electron mobility arising from the conduction minibands for periodic InSb QD superlattices. The calculations consist of three steps. First we calculated the QD potential and eigenfunctions using the empirical pseudopotential method. The next step is to solve within the tight binding approach a periodic potential built upon this QD. Finally, we use the Fermi Golden Rule to calculate the electron scattering rates due to the presence of different sized, non-periodic QDs. These scattering rates are combined with the carrier velocity and Fermi energy level to obtain a temperature dependent mobility tensor, which is then diagonalized.

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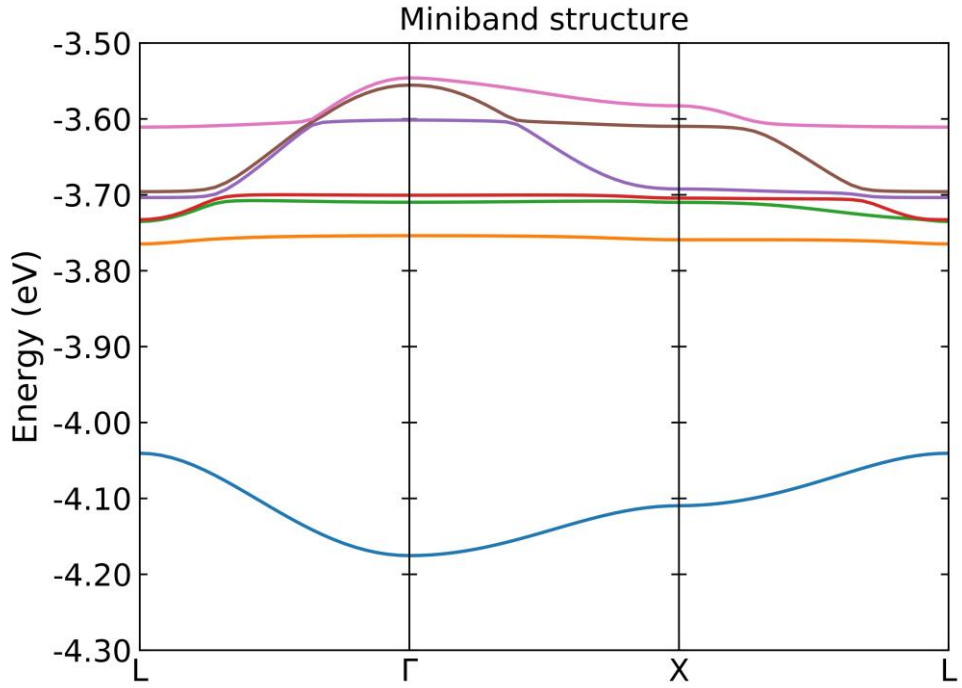

Fig.1: Band structure for the InSb QD superlattice with a lattice constant of 2.6 nm. QDs are one bond-length apart from each other. The energy reference is the vacuum

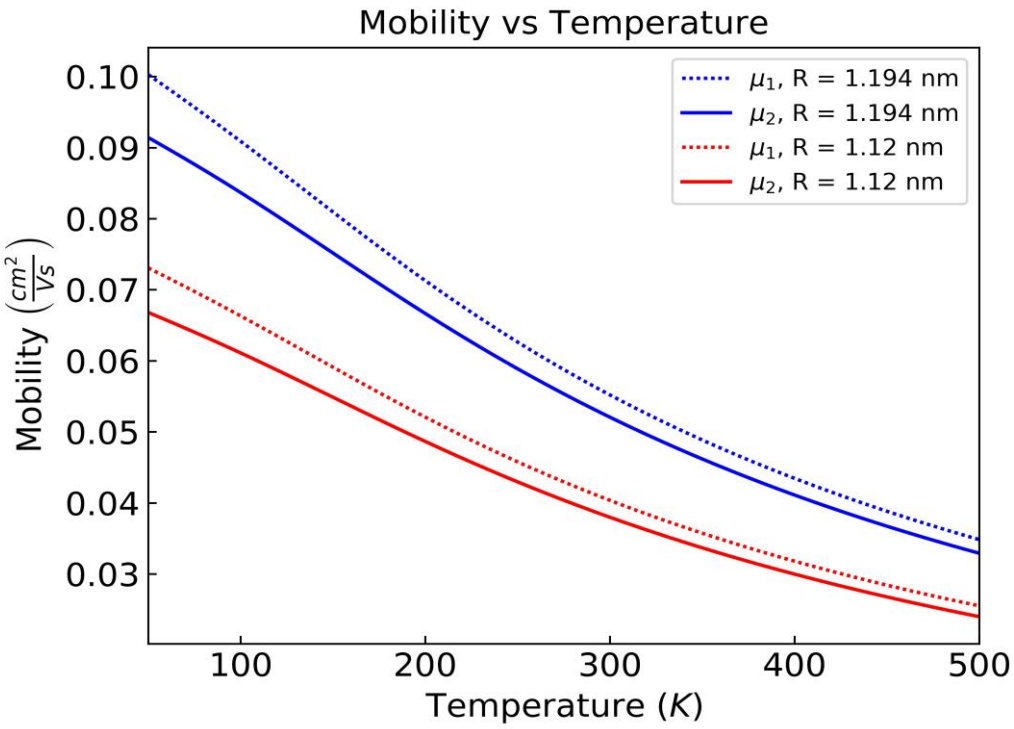

Fig.2 : Mobility eigenvalues for two different non periodic QD radius, 1.194 nm and 1.12 nm, at 1% concentration.