Abstract Submitted
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On the possibility of population inversion in strained silicon nanowires: an atomistic study DARYOUSH SHIRI, Institute for Qauntum Computing (IQC), University of Waterloo, AMIT VERMA, Texas A&M University-Kingsville, ANANT ANANTRAM, University of Washington — Density functional theory and Ensemble Monte Carlo studies show the possibility of population inversion in strained silicon nanowires. At room temperature and electric field of 15 KV/cm, a strain induced indirect subband can hold 10 times more electron population compared to the direct subband. The most dominant mechanism which depletes the indirect subband is scattering by longitudinal optical (LO) phonons. At T=300K the inter-sub band scattering is almost symmetric with the rate of 10^{11} s^{-1}. On the other hand the processes of thermalization to the bottom of the indirect subband (via acoustic phonon emission) and the 2nd order radiative recombination are very slow (10^{-9} sec and 10 sec, respectively). At T=77K the LO-phonon absorption rate (indirect to direct subband scattering) drops to 10^{8} s^{-1}. This induced asymmetry in scattering leads to the enhanced population difference between indirect and direct subbands even at higher electric fields. The spontaneous emission time is 10^{-7}sec and a few seconds for direct and indirect bandgap nanowires, respectively. This study suggests the usability of strained silicon nanowires in nano-lasers.

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