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Interface roughness scattering in p-Si/SiGe asymmetric quantum wells MARCO CALIFANO, N.Q. VINH, P.J. PHILLIPS, Z. IKONIC, R.W. KELSALL, P. HARRISON, C.R. PIDGEON, B.N. MURDIN, D.J. PAUL, P. TOWNSEND, J. ZHANG, I.M. ROSS, A.G. CULLIS, School of Electronic and Electrical Engineering, University of Leeds, U.K. — Of paramount importance in the design of a quantum cascade laser is the ability to engineer carrier lifetimes. These can be strongly influenced by the quality of the interfaces: fluctuations in the well width result in local fluctuations of the carriers' confining potential, which act as a scattering potential. We report the direct determination of non-radiative lifetimes in Si/SiGe asymmetric quantum wells designed to access spatially indirect interwell transitions between heavy-hole states, at photon energies below the optical phonon energy. We show both experimentally and theoretically that, for the interface quality currently achievable experimentally interface roughness will dominate all other scattering processes up to about 200 K. By comparing our results obtained for two different structures we deduce that in this regime both barrier and well widths play an important role in the determination of the carrier lifetime. Comparison with recent data for III-V multiple quantum wells leads us to the conclusion that the dominant role of interface roughness scattering at low temperature found here is a general feature of a wide range of semiconductor heterostructures not limited to IV-IV materials.

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