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Electron-phonon Interaction in Si Quantum Dots Interconnected with Thin Oxide Layers SHIGEYASU UNO, (Hitachi Cambridge Laboratory, Cambridge, U.K.), NOBUYA MORI, (Osaka University, Osaka, Japan.), KAZUO NAKAZATO, (Hitachi Cambridge Laboratory, Cambridge, U.K.), NOBUYOSHI KOSHIDA, (Tokyo University of Agriculture and Technology, Tokyo, Japan.), HIROSHI MIZUTA, (Tokyo Institute of Technology, Tokyo, Japan.) —

Recently, electron transport along 1D array of Si quantum dots interconnected with thin oxide layers has attracted growing attention due to the experimental observation of ballistic electron emission [1]. In this work, we calculated electron-phonon interaction in the 1D array of the Si quantum boxes of 4nm per side, interconnected with oxide layers of 1nm. The electron minibands were calculated using the Krönig-Penny potential, and the phonon normal modes were numerically calculated using the atomic linear chain model, where the difference of the Young's modulus of Si and oxide was taken into account. Our calculation revealed the following characteristics:
(1) The acoustic deformation potential in the Si regions is weaker than the one in the 1D quantum wire, because the "softer" oxide layers "absorbs" the strain from the Si regions.
(2) Intra-miniband phonon emission rate increases compared to that of the 1D quantum wire.
(3) At near the bottom of the minibands, energy loss rate, defined as the expectation value of energy loss per unit time, significantly decreases compared to that of the 1D quantum wire.
(4) Inter-miniband scattering cannot occur when the bandgap between minibands are larger than 0.06eV, the maximum phonon energy in this system.
The above characteristics suggest that the electrons rapidly lose their energy in each miniband, and that they maintain their energy at near the bottom of the miniband. This may lead to less energy dissipative electron transport.

[1] Koshida *et al.*, Appl. Surf. Sci., 146, pp. 371-376, (1999).

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