Dependence of Averaged Electron Energy Loss Rate on Well Width and Al Composition in $GaAs/Al_xGa_{1-x}As$ Quantum Wells

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In this work we present the calculation results of the averaged electron energy loss rate (ELR) in $GaAs/Al_xGa_{1-x}As$ quantum wells based on the dielectric continuum model with hot phonon effect. Strong dependence of the ELR on the width of the quantum wells and the Al compositions of the barrier were found.

Based on the dielectric continuum model, confined LO mode, half space LO mode and interface mode including symmetric plus (S+) and symmetric minus (S-) were considered in our calculations. The averaged ELR was calculated by averaging the contributions all phonon modes. We assume that the electron distribution satisfies quasi-thermal equilibrium at a hot carrier temperature of T_c=600K and such electron distribution was taken into consideration for the calculation of the net phonon generation. Fig.1 shows the dependence of the ELR on the width of the quantum well. For a given Al composition, the ELR reaches a maximum value at a certain width. This is because that contributions from the S+ mode and the confined LO mode have different dependence on the well width. The ELR due to the S+ mode decreases while the ELR due to the confined LO mode increase when the well width is increased. In Fig. 2 we shows the dependence of the ELR on the Al composition in the barriers. As the Al composition increase, the averaged ELR increase. This is because of the enhanced electron confinement in the well and the increased electron-optical phonon interaction. In conclusion, we have calculated the ELR for $GaAs/Al_xGa_{1-x}As$ quantum wells based on the dielectric continuum model with hot phonon effect. The dependence of the ELR on the well width and the Al composition were investigated and significant changes of the ELR were first found when the well width or the Al composition in the barriers was varied.

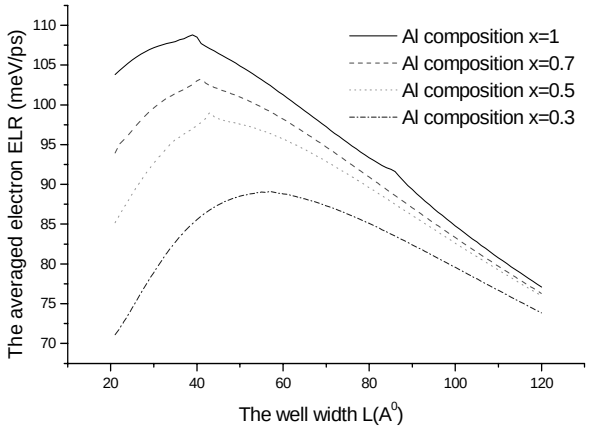

Fig.1

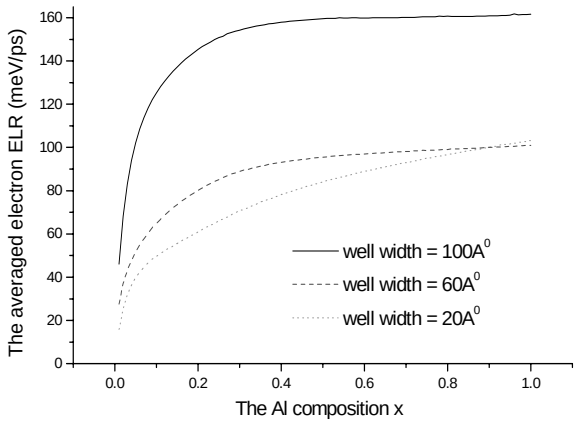

Fig. 2