High fT and fmax of double δ-doped GaInSb channel HEMTs

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We previously reported current-gain cutoff frequency (fT) of over 300 GHz for single δ-doped AlInSb/(Ga)InSb high electron mobility transistors (HEMTs) with 25-nm-thick AlInSb barrier. In this study, we employed thinner 20-nm-thick $Al_{0.40}In_{0.60}Sb$ barrier and double δ-doped structure. The double δ-doped structure enables to shorten the gate-channel distance while keeping high sheet electron density (Ns), which is favorable to increase fT and maximum oscillation frequency (fmax) of HEMTs.

Figure shows the gate length (Lg) dependence of the fT and fmax for the single and double δ-doped $Al_{0.40}In_{0.60}Sb/Ga_{0.22}In_{0.78}Sb$ HEMTs. We succeeded in achieving the highest fT of 342 GHz (Lg = 50 nm) and a higher fmax of 451 GHz (Lg = 70 nm) by adopting the double δ-doped structure.

To explain the fT results, we carried out delay time analysis. For the single δ-doped HEMT, the parasitic delay time (τp) increased from 0.10 to 0.15 ps even though the intrinsic delay time (τi) decreased from 0.43 to 0.39 ps by reducing the barrier thickness from 25 to 20 nm. Meanwhile, for the double δ-doped HEMT, the τp decreased from 0.15 to 0.10 ps while the τi decreased from 0.39 to 0.37 ps. This indicates that a higher Ns is kept even in the case of a thin barrier, resulting in a lower parasitic resistance for the double δ-doped structure. The double δ-doped GaInSb HEMTs in this study show one of the superior RF performances among Sb-based transistors.