MBE による(113)A GaAs 基板上における AlAs/Ge/AlAs ヘテロ構造の副格子交換

Sublattice Reversal in AlAs/Ge/AlAs Heterostructures Grown on (113)A GaAs Substrate

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We have demonstrated sublattice reversal (SR) in GaAs/Ge/GaAs heterostructures on high-index (113)B GaAs substrates grown by molecular beam epitaxy (MBE).[1,2] SR can be used as an alternative and more versatile method to reverse the sign of $\chi^{(2)}$ (second-order nonlinear susceptibility), which is essential in a novel terahertz (THz) device proposed by our group.[3,4] THz signal results from difference-frequency generation using two-color lasers around 920 nm in this device.[5,6] From the viewpoint of practical device applications, AlAs/Ge/AlAs heterostructures with a higher barrier layer are required to avoid the absorption of lasers. Noted that in our previous research, SR was not achieved in GaAs/Ge/GaAs heterostructures grown on the (113)A GaAs substrate.

In this research, we investigated AlAs/Ge/AlAs heterostructures grown on (113)A and (113)B GaAs substrates by MBE as shown in Fig. 1. Cross-sectional SEM images of the anisotropic etching profiles of samples grown on (113)B and (113)A GaAs substrates are shown in Figs. 2(a) and (b), respectively. Figs. 2(c) and 2(d) are the enlarged views of (a') in Fig. 2(a) and (b') in Fig. 2(b), respectively. SR was not achieved for the heterostructures grown on the (113)B GaAs substrate, as shown in Fig. 2(c), where the mesas of lower and upper GaAs both have forward mesa shapes. On the other hand, the SR was observed for the heterostructures grown on the (113)A GaAs substrate as shown in Fig. 2(d). The mesa shape for the lower GaAs layer is inverse mesa shape, whereas that for the upper GaAs layer is forward mesa shape. These results indicated that SR was achieved in AlAs/Ge/AlAs grown on the (113)A GaAs substrate.

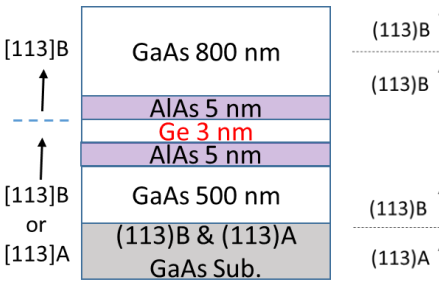

Fig. 1. Epitaxial structure

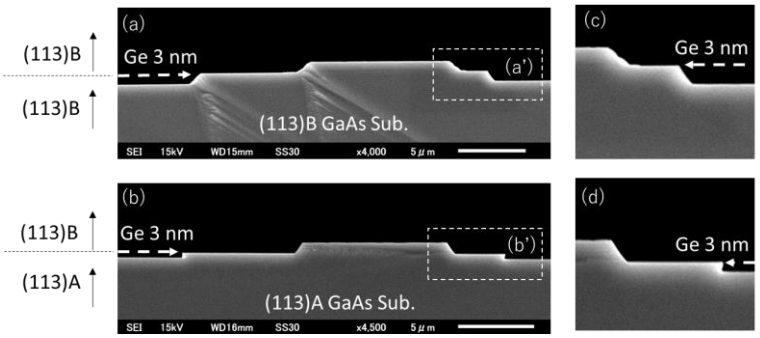

Fig. 2 Cross-sectional SEM images of etching profiles

1). X. M. Lu *et al.*, APEX **11**, 015501 (2018). 2). X. M. Lu *et al.*, JJAP **57**, 04FH07 (2018). 3). T. Kitada *et al.*, APL **95**, 111106 (2009). 4). T. Kitada *et al.*, APL **102**, 251118 (2013). 5). Y. Minami *et al.*, JJAP **56**, 04CH01 (2017). 6). T. Kitada *et al.*, JJAP **57**, 04FH03 (2018)