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Growth and magnetotransport measurements of triple-valley high mobility, miscut (111) AlAs quantum wells

SUNANDA PRABHU-GAUNKAR, M. GRAYSON, Dept. of Electrical Engineering and Computer Science, Northwestern University, F. HERZOG, G. KOBLMUELLER, Walter Schottky Institut, Tech. Univ. Munchen — We optimize growth of AlAs on (111)B GaAs substrates and perform magnetotransport measurements on vicinal (111)AlAs quantum wells (QWs). Previous literature reports that MBE growth on exactly oriented GaAs (111)B substrates is difficult, and the grown epi-layers are obscured by pyramid-like surface faceting and twin defect formation; slight substrate miscut results in stable step-flow growth. We perform a combined structural analysis with AFM, TEM and XRD to correlate MBE growth conditions with defect density scaling. We find that a high growth temperature of 690° C and low As beam fluxes reduce micro-twin formation for exactly oriented substrates and eliminate them for miscut substrates. A slight miscut of 2°, at which slip-step growth is known to occur, lead to AlAs QWs with record electron mobility μ = 13000 cm^2/Vs at a sheet density $n_{2D} = 2.17 \times 10^{11}$ cm^{-2}. Numerical calculations reveal that valley splitting is about 1 meV per degree of miscut, which compares to typical Fermi energies of 2DEGs in AlAs QWs. Signatures in the transport data indicate that not only miscut but also exchange splitting between valleys can play an important role. Magnetotransport data at 15 mK in magnetic fields up to 15 T will also be presented.

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