MBE Growth of High-Density InAs/InAsSb Nanowires on Si(111) Substrates and Their Mid-Infrared Emission

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One-dimensional nanowires (NWs) of III-V semiconductors on silicon has been proposed to be an ideal candidate for advanced silicon-based optoelectronics. For their device applications, it is necessary to develop various growth techniques such as NW size control, high density NWs, vertical heterostructures, core-shell structures, and NW arrangement. In this conference, we present the fabrication of high-density InAs/InAsSb NWs on Si substrates and their mid-infrared emission.

In this study, the InAs/InAsSb NWs were grown on Si(111) substrates by molecular beam epitaxy (MBE). After forming pinholes on the silicon oxide film using gallium droplets, InAs/InAsSb NWs were grown a 450 °C by simultaneously supplying indium and arsenic molecular beams. In photoluminescence (PL) measurements of NWs, a semiconductor laser (980 nm, 200 mW) and PbS and FT-IR photodetectors were used.

Figure 1 shows a SEM image of InAs/InAsSb/InAs double-hetero NWs on Si(111). The NW density was 7×109 cm-2. The average width and length of NWs were 48 nm and 380 nm, respectively. The RHEED patterns showed wurtzite and zinc blende structures during the growth of InAs and InAsSb, respectively. Figure 2 shows PL spectrum of high-density InAs/InAsSb/InAs double-hetero NWs, measured at 4 K. The PL main peak energy appeared at 0.373 eV (3.32 µm), due to the type-II transition between InAs and InAsSb. Additionally, a sub-peak at 0.35 eV (3.53 µm) was observed. This is probably originated from the impurity/defect-related emission. The high-density NW structures including the InAs/InAsSb type-II multi-hetero interfaces are expected to be applied to mid-infrared devices.