Characteristics of ultra-thin InN films grown on AlN

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InN is a promising material for high-frequency field-effect transistors because it has the highest electron mobility and velocity among the group-III nitrides. At this moment, the reports on InN-based transistors are limited due to the difficulty in controlling the electron density at the surfaces and interfaces. We expect that such high-density electrons in InN will be controlled by forming an interface with AlN that possesses large spontaneous polarization. However, the details of structural and electrical characteristics of heterointerfaces between InN and AlN remain to be clarified. In this study, we grew ultra-thin InN films on high-quality AlN templates and investigated their characteristics.

InN films were grown on AlN templates by sputtering. The AlN templates were prepared on sapphire substrates by several growth techniques including HVPE, MOVPE, and sputtering. The electrical and structural properties of the ultra-thin InN films were investigated by Hall effect measurement, X-ray diffraction, and atomic force microscope.

InN films were grown on commercially-available Al-polar AlN templates, which were prepared by MOCVD (template A) and HVPE (template B). The full widths at half maximum of the 0002 rocking curves for AlN templates A and B were 65 and 80 arcsec, respectively. The AlN template A has atomically flat surfaces with monolayer steps [Fig.1(a)] while there were hexagonal islands on the surface of the AlN template B [Fig. 1(b)]. Figures 1(c) and 1(d) show the surface morphology of 7-nm-thick InN films grown on the AlN templates A and B, respectively. The root mean square value of the surface roughness for the ultra-thin InN grown on the AlN template A is smaller than that grown on the AlN template B. These results indicate that the surface roughness of AlN template strongly affects the morphology and the growth mode at the initial stage of InN growth.

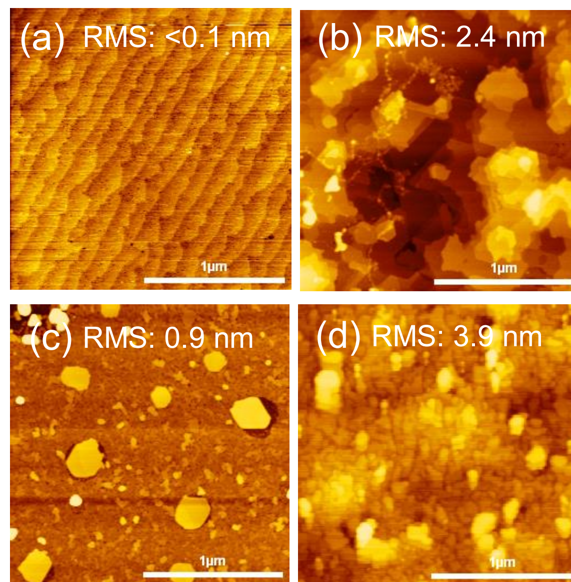

Fig.1 AFM images of AlN templates prepared by (a) MOCVD (template A) and (b) HVPE (template B), and ultra-thin InN films grown on the AlN templates (c) A and (d) B.

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