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Nucleation layer temperature effect on AlN epitaxial layers grown by metalorganic vapour phase epitaxy

Irem Simsek[1,2], Gamze Yolcu[1,2], MerveNur Koçak[1,2], Kağan Pürlü[1,2], Ismail Altuntas[1,2], and Ilkay Demir[1,2,*]

[1] *Nanophotonics Research and Application Center, Sivas Cumhuriyet University, 58140 Sivas, Turkey*
[2] *Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey*

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ABSTRACT

AlN samples have been grown on sapphire substrate using nucleation layers (NLs) having different growth temperatures. The growth temperature of the NL has been varied over a wide range of temperatures highlight the effects on the quality of the AlN epilayer. The AlN samples have been characterized by high-resolution X-ray diffraction (HRXRD), atomic force microscope (AFM), Raman scattering spectrometer, and spectrophotometer. The obtained results demonstrate the temperature of NL has a direct effect on the quality of the AlN sample and occurs major differences in the quality of structure, surface morphology, and amount of strain in the AlN epilayers. Based on HRXRD measurement results, when the growth temperature of AlN NL is raised to 1075 °C, the crystal quality has improved owing to both the density of AlN nucleation islands reduction and the grain size outgrow. However, continuing to increase the growth temperature of the AlN NL layer begins to degrade the quality. In addition, the findings obtained from the Raman measurement demonstrates that the tensile stress can be control through NL growth temperature. Therefore, as can be seen from the characterization results, the growth temperature of AlN NL is important to obtain an AlN sample with high quality.

1 Introduction

Compounds formed by III-N elements are used in many areas for electronic and optoelectronic device applications due to their advantages such as wide bandgap and high breakdown voltages. These have become the focus of attention for electronic and optoelectronic device applications used in many fields with their potential in water purification, sterilization, defense industry, secure communication, white-light illumination and optical storage areas [1–4]. Although AlN is an ideal substrate because of its high thermal conductivity (590 W/mK), wide bandgap (6.2 eV), and perfect lattice compatibility with gallium nitride, its use is severely restricted due to its high substrate cost [5, 6]. For AlN, sapphire is one of the most popular substrates due to its reduced cost, wide availability, and chemical–

Address correspondence to E-mail: idemir@cumhuriyet.edu.tr

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