Properties of epitaxial AlN thin film deposited on sapphire substrate by ECR plasma

Satoru Kaneko[1)], Takeshi Ito,
Manabu Yasui, Masahito Kurouchi
Kanagawa Industrial Technology Center
Kanagawa Prefectural Government
Ebina, Kanagawa, JAPAN
1) satoru@kanagawa-iri.go.jp

Hironori Torii, Takao Amazawa
MES-AFTY
Hachiouji, Tokyo, JAPAN

Akinori Fukushima, Takashi Tikumasu
Institute of Fluid Science
Tohoku University
Sendai, Miyagi, JAPAN

Takatoshi Nagano
Department of Enginnering
Ibaraki University
Ibaraki, JAPAN

Lee Seughwan, Sungkyun Park
Department of Physics
Pusan National University
Busan, KOREA

Hirofumi Takikawa
Department of Electrical and
Electronic Information Engineering
Toyohashi University of Technology
Toyohashi, Aichi, JAPAN

Abstract—**We prepared AlN film on c-plane sapphire substrate by electron cyclotron resonance plasma-enhanced sputtering deposition (ECR-sputtering). X-ray diffraction (XRD) verified the epitaxial growth of AlN films with the full width at half maximum (FWHM) of rocking curve of 0.04 deg. even on the film thickness of 100 nm. XRD also verified slight change of peak position from AlN film along both out of plane and in-plane directions.**

Keywords - Aluminam Nitridet; Epitaxial; thin film; Wide Gap; transmittancy; ECR-sputtering; Crystal Structure; first priciple theory; Lattice Constant

I. INTRODUCTION

Wurtzite Aluminum Nitride (hex-AlN) exhibits a large piezoelectric property, a high ultra-sonic velocity as well as a wide direct band gap up to 6.2 eV. Optoelectronics, such as high brightness light-emitting devices is expecting as an application using the wide band gap of the hex-ALN, and surface acoustic wave (SAW) modulators, film bulk acoustic wave (BAW) resonators, and sensors are expected as for other aspect of hex-AlN.

In epitaxial growth of thin film undesired factors are strain caused by lattice mismatch and difference in thermal expansion between thin film and substrate. Rieger et. al. investigate the influence of stress on energy gap by controlling stress with thickness of buffer layer[1]; epitaxial Gallium Nitride (GaN) grows on sapphire substrate with varied thickness of AlN thin film as a buffer layer. Large strain caused in epitaxial MgO film resulted in the reduction of lattice constants along both out-of-plane and in-plain directions. The first principle theory showed Schottky default was one of reason for the reduction of lattice constants[2].

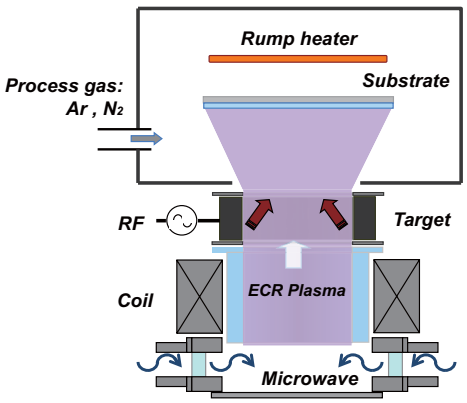

Figure 1. Solid-source cyclotron resonance (ECR) sputtering deposition system (MES-AFTY AFTEX-6000). Substrate holder rotates during deposition and the temperature was varied by a ramp heater.

In this study, epitaxial AlN films were prepared on sapphire substrates (c-axis) by electron cyclotron resonance plasma-enhanced sputtering deposition (ECR-sputtering). Interestingly, the epitaxial AlN films showed lattice constants different than the bulk AlN materials along both surface-normal and in-plane directions. The first principle theory was employed to evaluate stability of total energy with the varied lattice constants. The effect of varied lattice constants on band gap was estimated by using the GW approximation (GWA). To be compared with the theoretical results, the evaluation of bandgap are experimentally in progress.