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Synchrotron X-ray scattering study on oxidation of epitaxial AlN films on Sapphire(0001), Si(001), Si(111) substrates

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Recently, the aluminum oxide films have been widely investigated for the insulating layer of Si-based devices, coating technologies, and the optical applications due to their thermal stability and optical transparency. In practical applications, the aluminum oxide requires the stable crystal structure of high density. It is suggested that the deposition of aluminum oxide and the oxidation of AlN for preparation of the crystal oxide film. In case of oxidation of AlN, the quality of the host AlN film limits the crystal quality of the aluminum oxide film. The goal of this study is to reveal the oxidation process of AlN, and to provide structural information for the resulting aluminum oxide film.

In this paper, we present synchrotron X-ray scattering study on the structural transformation of epitaxial AlN film into epitaxial γ-Al2O3 film by thermal oxidation. The nano-sized crystalline γ-Al2O3 is initially formed on the AlN surface, while the host AlN is reduced simultaneously. As the oxidation temperature increases, all the AlN film transforms to a γ-Al2O3 film, and the domain size and the lattice constant of crystalline γ-Al2O3 increases due to the change of oxygen content. The spinel γ-Al2O3 film has the epitaxial relationship with the host AlN and the sapphire, Si(001), and Si(111) substrate.