Epitaxial growth of Ga_2O_3 films with different ligand structures by mist chemical vapor deposition

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Recently, gallium oxide (Ga_2O_3) has been receiving attentions for the next-generation power semiconductors such as electric vehicles, solar inverters, and energy storage devices because of having a wide band-gap of 5.3eV. In particular, beta phase gallium oxide is thermally stable and is formed as a large and single crystal wafer. In order to form epitaxial β-Ga_2O_3 films, hydride vapor phase epitaxy, metal organic chemical vapor deposition, pulsed laser deposition, molecular beam epitaxy, and mist chemical vapor deposition (mist-CVD) have been proposed. Among them, mist-CVD can easily control the chemical compositions and phases as well as do low-cost deposition due to simple equipment without vacuum systems.
Here, we studied the effect of precursor ligand types ($Ga(acac)_3$, $GaBr_3$, GaI_3) and growth temperatures (400°C – 700°C) on heteroepitaxial Ga_2O_3 films on the (0001) sapphire substrates using mist-CVD method.
We confirmed that crystallinity and phases strongly depended on precursor ligands and temperatures. Through the x-ray diffraction, we analyzed the crystal structures of Ga_2O_3 films. At 400°C and 500°C temperatures, the (0006) α-phase was observed in Ga_2O_3 films and the optimal phase of α-Ga_2O_3 films was grown by $Ga(acac)_3$. At 600°C temperature, the (0004) ε-phase was observed in Ga_2O_3 films and the optimal phase of ε-Ga_2O_3 was grown by GaI_3. At 700°C temperature, the (-402) β-phase was observed in Ga_2O_3 films and the optimal phase of β-Ga_2O_3 was grown by GaI_3. The images of electron backscattering diffraction showed that the crystallinity of Ga_2O_3 grown by precursor ligand types is the single crystal epitaxial growth.
As a result, we confirmed that a carbon free-xxx precursor was a good candidate to form high-quality β-Ga_2O_3 epitaxial films and it would be useful to understand the epitaxial growth of metal oxide semiconductors using a mist-CVD method.

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