High-rate growth of pure *β*-Ga_2O_3 thick layers on 2-inch-diameter substrates by hot-wall metalorganic vapor phase epitaxy

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In order to demonstrate power devices using *β*-Ga_2O_3, which is expected to have a high breakdown electric field strength (> 7 MV/cm) due to its large bandgap of 4.5 eV or larger [1], much effort has been paid to prepare their drift layers using various epitaxial growth methods. Among them, metalorganic vapor phase epitaxy (MOVPE) is one of the preferred growth methods for fabricating advanced drift layers, which require particularly complex designs, because it enables precise growth control and formation of heterointerfaces through alloy growth. Recently, our group demonstrated the MOVPE growth of high-purity *β*-Ga_2O_3 thin layers with reduced hydrogen (H) and carbon (C) contamination under optimal conditions found through thermodynamic studies [2,3]. In this study, high-rate growth of thick *β*-Ga_2O_3 layers was attempted while maintaining high purity.

MOVPE growth of *β*-Ga_2O_3 was performed using trimethylgallium (TMG) and oxygen (O_2) precursors and Ar as a carrier gas in a horizontal low pressure hot-wall MOVPE reactor (TAIYO NIPPON SANSO CORPORATION, FR2000-OX) in the growth temperature range of 900 – 1050 °C. Under a constant O_2 supply, TMG supply rate was varied in the range of 111 – 546 μmol/min. At the same time the input VI/III ratio ($2P^{o}_{O2}/P^{o}_{TEGa}$) changed from 1609 to 327 where P^{o}_{O2} and P^{o}_{TEG} are input partial pressures of O_2 and TMG, respectively. A 2-inch c-plane sapphire and a 10 mm × 15 mm sized *β*-Ga_2O_3(010) were used as substrates for hetero- and homoepitaxial growth, respectively. Depth profiles of impurity concentrations in the grown layers were evaluated by means of secondary ion mass spectrometry (SIMS).

It was confirmed that the growth rate did not differ between hetero- and homoepitaxial growth under any condition. At the growth temperature of 1000 °C, the growth rate was about 3 μm/h with the TMG supply rate of 111 μmol/min and varied linearly up to about 15 μm/h with the increase of TMG supply rate. However, the C impurity concentration increased as the TMG supply rate increased. For the homoepitaxial growth with the TMG supply rate of 182 μmol/min and the input VI/III ratio of 981, the growth rate was constant at about 4.5 μm/h regardless of the growth temperature. However, it was shown that the concentration of H and C impurities increased as the growth temperature decreased. These impurity concentration increases are probably due to the increase of hydrocarbons derived from TMG and their insufficient combustion. On the other hand, Si impurity concentration was below the B.G. level (2.0×10^{15} cm^{-3}) at all growth temperatures.

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