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ABSTRACT

Owing to the large differences in the chemical properties between Al and N polarities in aluminum nitride (AlN), the choice of the polar direction for crystal growth strongly affects not only the quality but also the shape (facet formation) of the grown crystal. In particular, N-polar (0 0 0 −1) has been considered to be a more preferable direction than Al-polar (0 0 0 1) for sublimation growth because compared to Al-polar (0 0 0 1), N-polar (0 0 0 −1) exhibits better stability at high growth rate (high supersaturation) conditions and enables easier lateral enlargement of the crystal. However, some critical growth conditions induce polarity inversion and hinder stable N-polar growth. Furthermore, the origin of the polarity inversion in AlN growth by the sublimation method is still unclear. To ensure stable N-polar growth without polarity inversion, the formation mechanism of the inversion domain during AlN sublimation growth must be elucidated. Therefore, herein, we demonstrate homoepitaxial growth on an N-polar seed and carefully investigate the obtained crystal that shows polarity inversion. Annular bright-field scanning transmission electron microscopy reveals that polarity is completely converted to the Al polarity via the formation of a 30-nm thick mixed polar layer (MPL) just above the seed. Moreover, three-dimensional atom probe tomography shows the segregation of the oxygen impurities in the MPL with a high concentration of about 3 atom%. Finally, by avoiding the incorporation of oxygen impurity into the crystal at the initial stage of the growth, we demonstrate an effective reduction (seven