Identification of hydrogen-induced changes in atomic deformation of ferroelectric SrBi2Nb2O9 thin film using transmission electron microscopy

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Abstract

It is well known that the hydrogen annealing process cause serious degradation of Bi-layered perovskite materials. However, even if hydrogen-induced SBN degradation mechanism must be investigated with atomic level by using HRTEM, many published works have focused on the electrical degradation of the ferroelectric capacitor during hydrogen annealing. It is due to the difficulty of experiments and highly complicated SBN structure. Thus, there is little research on the microstructure degradation. In this work, for the first time, we investigated microstructure changes on the surface of SrBi2Nb2O9 films during hydrogen annealing using the high resolution transmission electron microscopy (HR-TEM). In order to investigate the same area before and after hydrogen annealing exactly, we prepared the TEM samples of the crystallized SBN thin films prior to each annealing process. Then the TEM investigations for hydrogen effect on microstructure are as following; first, the atomic structure of the specific region in the SBN film before hydrogen annealing was investigated using a HRTEM. Second, the TEM sample was annealed at 435oC in 3% of hydrogen containing ambient for 15min, and then the same region of the TEM sample was investigated by HRTEM. As a result, after hydrogen annealing at 435oC for 15min under P(H2)=2 Torr, we found that inter-plane distance of normal 1 1 5 planes (3.081Å) is reduced 3.056 Å due to the shift in the atomic arrangement of 1 1 5 planes. Consequently, Bi-layered perovskite structure will be transformed, resulting in degradation of ferroelectric property after hydrogen annealing.