Dynamic Observation of Nanoscale Domain Switching Behaviors in Ferroelectric HfO₂ films Using Scanning Nonlinear Dielectric Microscopy

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Orthorhombic-phase HfO_2 thin films are attracting considerable attention as novel ferroelectric materials which possess excellent ferroelectric property with a thickness less than 20 nm. However, there remain many unexplained parts concerning nanoscale domain switching behavior in these films. Thus, we attempted a dynamic observation of nanoscale domain switching behavior using scanning nonlinear dielectric microscopy (SNDM).

Figure 1 shows the experimental setup in this study. The setup is almost the same as conventional SNDM system excepting that an additional voltage source for bias voltage application is installed to the system. Several Y-doped HfO₂ (Y:HfO₂) films with different process parameters were prepared as measurement samples. Figure 2 shows the typical response signals observed by the proposed method. The appearance of observed response signals varied depending on the film orientation. The difference in the crystallization process also affected the measurement results. These differences in response signals are considered to be derived from the difference in domain switching behaviors in nanoscale region.



Figure 2. SNDM response signals of Y:HfO₂ films with bias voltage application

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