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BaTiO₃- Bi(Mg_{2/3}Nb_{1/3})O₃ Epitaxial Thin-films for High-temperature Capacitors 1 National Institute for Materials Science (NIMS), International Center for Materials Nanoarchitectonics (WPI-MANA), 1-1 Namiki, Tsukuba 305-0044, Japan 2 COMET Inc., c/o NIMS, 1-1 Namiki, Tsukuba 305-0044, Japan °Somu Kumaragurubaran¹, Takahiro Nagata¹, Kenichiro Takahashi², Sun-Gi Ri², Yoshifumi Tsunekawa² Setsu Suzuki² and Toyohiro Chikyow¹

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SiC has emerged as the next generation power semiconductor and SiC devices are capable of operating at temperatures in excess of 250°C and 500°C stable operation has also been demonstrated. In contrary, the capacitors currently available can operate up to 175°C only and are bulky too. Therefore, it is necessary to develop compact capacitors that can operate at least up to 400°C. The key issue is to develop a dielectric medium with high dielectric constant (ε r) and exceptional ε r stability at high temperatures. Relaxor ferroelectric BaTiO₃- Bi[Mg,Nb]O₃ (BT-BMN) bulk ceramics have been identified as a potential dielectric medium. However, a thin-film process technology has to be developed for monolithic integration of capacitor. Here, we demonstrate the epitaxial growth of BT-BMN thin-films on (100) SrTiO₃ (STO) substrate using pulse laser deposition method and its superior high temperature electrical characteristics.

A KrF pulse laser (248nm, 10Hz and $1.5J/cm^2$) was used to ablate the target of $0.6[BaTiO_3] - 0.4[Bi(Mg_{2/3}Nb_{1/3})O_3]$ composition. The deposition was performed at 490, 510 and 530°C at O₂ partial pressures 0.2, 2, and 20Pa. The films grown at 20Pa and 510°C showed epitaxial relationship with STO. Post-growth annealing improved the dielectric constant of the film and the highest value 385 @100kHz was obtained from 850°C annealed films. We altered the capacitor structure by introducing an epitaxial SrRuO₃ (SRO) between BT-BMN film and substrate. The 2D XRD pattern in Fig. 1a shows singular spots corresponding to (100) and (200) reflections. Fig. 1b depicts the pole figure projection of {111} reflections on (100) evidencing the epitaxial relationship films and STO. The dielectric constant increased remarkably with SRO intermediate layer. Fig. 1c shows the dielectric constant and dielectric loss as a function of temperature. Note that the dielectric constant exceeds 400 and the stability is <11% in the 80-400°C range. These values could be improved further when the interface is properly engineered.



Fig. 1 (a) 2D-XRD pattern and (b) pole figure of {111} reflections on (100) of BT-BMN/SRO/STO and (c) temperature dependency of dielectric constant and dielectric loss at 100kHz

