Selective growth and micro patterning of Au/Pb($Zr_{0.52}Ti_{0.48}$)O_3/$SrRuO_3$ film capacitor structure by water lift off process

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[Introduction]

Oxide based electronic devices have been developed due to the excellent and unique electrical properties of oxides, such as high-T_c superconductor, wide-gap semiconductor, and ferroelectrics. Concerning the miniaturization and high performance of such devices, the micro/nano fabrication technique for oxides is increasingly important. However, it is not easy to realize the high-etching rate for oxides due to its chemical stability. To overcome this problem, we have developed water lift-off (WLO) process [1]. In this work, we have prepared selective grown film capacitors of Au/Pb($Zr_{0.52}Ti_{0.48}$)O_3 (PZT)/$SrRuO_3$ (SRO) on *c*-plane sapphire by WLO process and investigated its structural and electrical properties.

[Experimental]

Patterned *a*-CaO films were prepared on *c*-plane sapphire substrate through photolithography process and deposition of *a*-CaO at R.T. by pulsed laser deposition (PLD), then followed by lift off process using acetone solution. SRO and PZT were deposited on the substrate at 720 and 630 °C, respectively by PLD. SRO and PZT films were patterned by removing *a*-CaO sacrificial layer in pure water. Upon completion of WLO process, line-patterned SRO bottom electrodes and square-patterned PZT films were formed on the substrate. Au top electrodes were deposited on the PZT films by thermal evaporation.

[Results and discussion]

Figure 1 shows an optical image of prepared patterned-film capacitor structures. Here, for comparison, conventional film capacitors were prepared on the same substrate. The lateral dimension of each patterned capacitor is about 20 µm and 50 µm, respectively. While the conventional capacitor is 50 µm. Patterned SRO and PZT films were successfully prepared without noticeable *a*-CaO residue on the substrate. This result shows that selective growth of each oxide films can be realized by WLO process.

Figure 2 shows polarization-voltage (P-V) curves of patterned and conventional film capacitors. Although observed P-V curves of patterned capacitors indicate clear ferroelectric behavior, their polarization value are slightly lower than that of conventional capacitor. Probably this is caused by the higher leakage current of patterned capacitor compared to that of conventional one (shown in the inset in Fig. 2), and observed higher leakage current might be occurred at the edge of line-patterned SRO bottom electrode. To investigate the influences of shunt components, we will evaluate the presence of unexpected structure such as over grown parts due to the selective growth process.

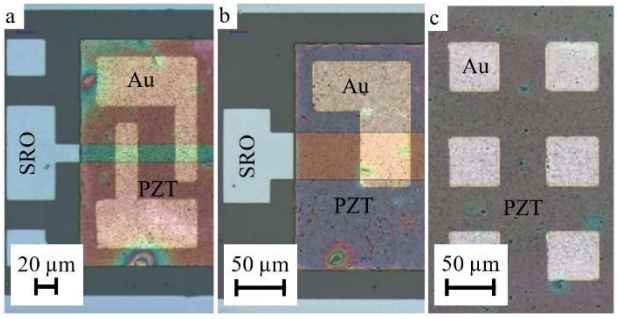

Fig. 1. Optical microscopy images of patterned and conventional film capacitors of Au/PZT/SRO structures with lateral dimension of (a) 20 µm, (b) 50 µm for patterned one, and (c) 50 µm for conventional one.

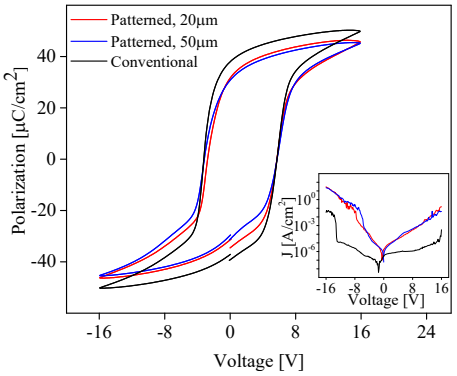

Fig. 2. Polarization v.s. voltage curves of patterned and conventional film capacitors of Au/PZT/SRO structures. The inset shows current density v.s. voltage characteristics of specimens.

[1] T. Kawae et al., IUMRS-ICAM 2012, C-3-026-004 (2012)

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