Electrical Properties of Epitaxially grown and Preferentially oriented CSD-derived $Pb(Mg_{1/3}, Nb_{2/3})O_3$-$PbTiO_3$ Thin films on Si substrate.

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Relaxor-type ferroelectrics, $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PMN-PT) ceramics and single crystals, have become one of the most promising materials to be used for piezoelectric actuators and sensors in MEMS application and energy harvesting devices due to its huge piezoelectricity (over 2000 pm/V). As we know, the construction of MEMS and energy harvesting devices involves many thin film deposition techniques and Si is the promising choice as a substrate. In addition, it is highly difficult to realize the strict composition control with desirable stoichiometric phase in films even at optimized processing conditions. Whereas in chemical solution deposition (CSD), it is relatively easy to control the composition and crystal symmetry of the resultant films by the molecular design of precursor solutions and suitable processing. To the best of our knowledge, there were no reports on the deposition of epitaxial PMN-PT thin films on a Si substrate by CSD. Hence, the present investigations are aimed to develop PMN-PT epitaxial and preferentially oriented thin films on Si substrates with CSD. To facilitate perovskite-type epitaxial growth of thin films, $LSCO/CeO_2/YSZ$ buffer layers have been introduced between a Si substrate and PMN-PT thin films using PLD. The preparation procedure of $LSCO/CeO_2/YSZ$ buffer layer on a Si substrate have been already reported [1]. CSD-derived $LaNiO_3$ (LNO) thin film electrode with preferred orientation have also been introduced between PMN-PT thin films and a Si substrate for the oriented films.

As a result, epitaxially grown or preferentially oriented PMN-PT thin films were deposited on $LSCO/CeO_2/YSZ/Si$ or LNO/Pt/Si substrate, respectively. Figure 1 shows change in the normalized d_{33} for PMN-PT thin films with a composition. YSZ and CeO_2 layers have been heteroepitaxially grown on a Si(001) substrate with cube-on-cube relation, and on the CeO_2 surface, the LSCO and PMN-PT thin films have been heteroepitaxially grown with 45° rotated cube-on-cube relation. These films exhibited excellent ferroelectric and piezoelectric properties and is shown in Fig. 1, as well as the results for the oriented PMN-PT thin films. This figure clearly exhibited the stress induced effect for the PMN-PT thin films on a Si substrate.

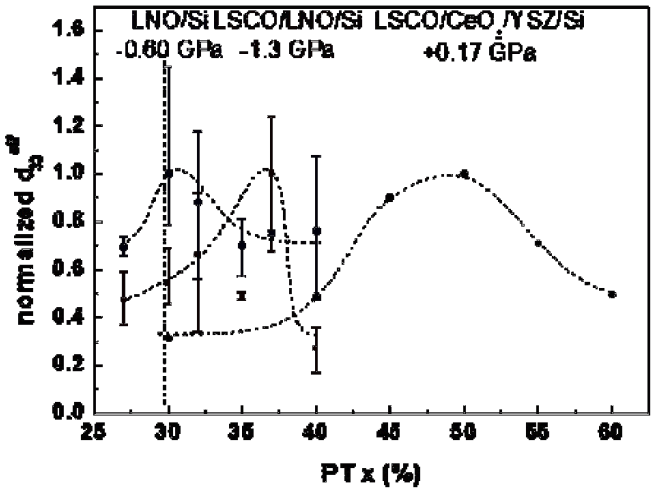

Figure 1 Normalized piezoelectricity for PMN-PT thin films as a function of composition.

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