Lowering Crystallization Temperature of Lead Zirconate Titanate (PZT) Thin Film Synthesized by Solution-Combustion Synthesis Method using a Lead Titanate (PTO) Seeding Layer

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Nowadays, flexible electronics gather increasing attention, however, to apply the most widely used ferroelectric PZT material on flexible substrates such as polyimide, a processing temperature as low as 350 ºC is normally required [1]. It has been reported that the perovskite transformation of PZT is a nucleation-controlled process, thus introducing a seeding layer, such as commonly used $PbTiO_3$ (PTO), could decrease the surface energy leading to increasing the kinetics of the nucleation, and hence, the crystallization temperature could be lowered [2].

In previous study, we proposed the solution-combustion synthesis (SCS) approach, hereafter so-called SCS-PZT, for fabrication of PZT thin-films at 450 ºC, which is far lower than the conventional crystallization temperature of PZT (>600 ºC) [3]. In this study, we combine the SCS method with introduction of a $PbTiO_3$ (PTO) seeding layer for further lowering the crystallization temperature.

To fabricate PZT thin-films with a PTO seeding layer, first the 0.1M PTO precursor solution (Pb/Ti ratio is 1:1) was spin-coated on a Pt/Ti/SiO_2/Si substrate, followed by pyrolysis at 250 ºC. Second, the PTO film was annealed at 400 ºC in ambient air for crystallization using a hot plate. In the next steps, the upper SCS-PZT layers were deposited on the PTO seeding layer under the same processes of pyrolysis and annealing. These processes were repeated two times to obtain a 36 nm SCS-PZT thin film. The perovskite nucleation growth process of fabricated PZT thin-films was investigated by scanning electron microscope (SEM, Hitachi SU8000). The nucleation of crystallized perovskite phase was clearly observed for the SCS-PZT thin film with the PTO seeding layer (Fig.1(a)), as compared to the film without the seeding layer (Fig.1(b)). The result suggests that the PTO seeding layer could lower the crystallization temperature of SCS-PZT thin film.

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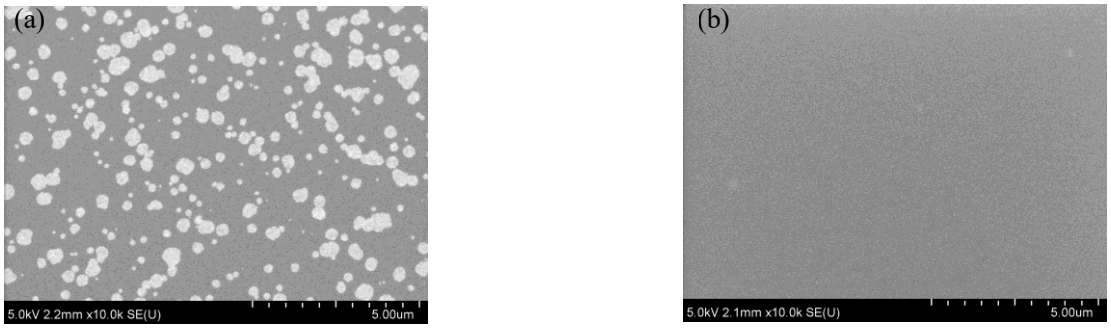

Fig. 1. Top-view SEM images of the SCS-PZT thin-films processed under 400 ºC: (a) with and (b) without the PTO seeding layer.