Influence of Thin Film Fabrication Process on Structural Properties of Perovskite-Oxide Based Proton Conductors

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Abstract

Proton conducting oxides have potential advantages in electrochemical device applications. Pulsed Laser Deposition (PLD) is a promising method to synthesize thin, gas-tight and chemically and mechanically stable electrolyte layers, which is a key process to realize such a device of high efficiency. In a conventional PLD process, crystalline thin films are grown by heating substrates, while we have demonstrated that deposition at low temperatures, i.e. without substrate heating, and post-annealing results in epitaxial crystallization when a single crystal substrate is used [1]. As summarized in the figure for thin films of $BaZr_{0.95}Y_{0.05}O_3$ (BZY5) and $SrZr_{0.95}Y_{0.05}O_3$ (SZY5) deposited on fused silica substrates, we have found that the crystallization temperature decreases significantly with increasing sputtering rate in this process. It should be noted that crystalline thin films of the BZY5 thin films are obtained even below 200°C in this process. From X ray absorption near edge structure (XANES) and TEM observation of as-deposited and post-annealed thin films, it is suggested that the formation of crystal nuclei might be the key process, which may depend largely on the PLD parameters.

On the other hand, it is suggested that the significant increase in thin film density from amorphous to crystalline phase may cause a very high in-plane tensile stress, which is also reported similarly for YSZ thin films [2].

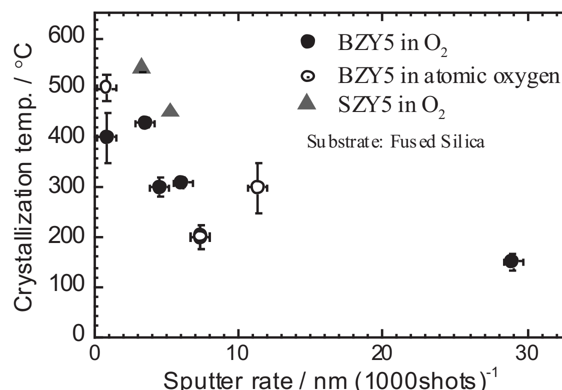

Fig. Crystallization temperature of BZY5 and SZY5 thin films as a function of sputtering rate of PLD.

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References

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