Low-temperature processing of flexible photoferroelectric $BiFeO_3$ thin films from self-induced solution seeding

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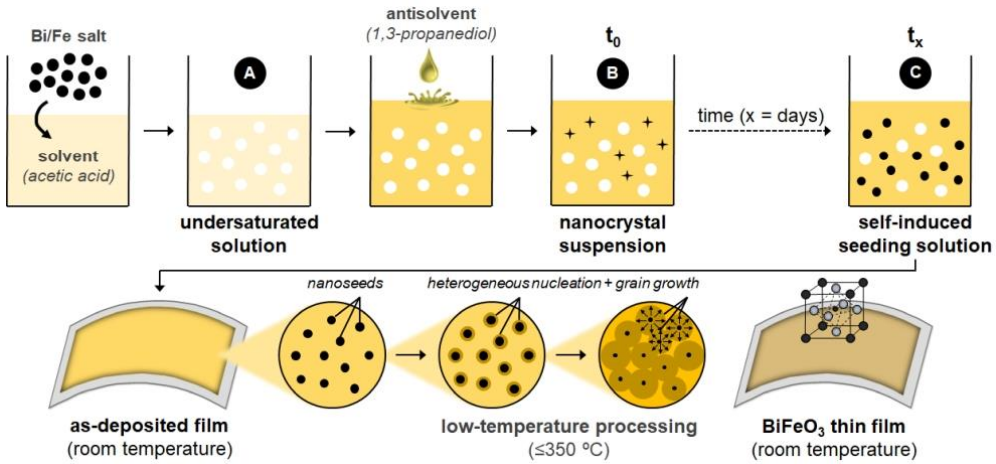
Seeding effect is a powerful strategy to induce the crystallization of metal oxide thin films at low temperatures [1]. Traditionally, the activation energy for the crystallization of the oxide phase can be reduced by promoting its heterogenous nucleation either on a seeding monolayer grown on the substrate or over the surface of seeding nanoparticles introduced previously into the precursor solution. Here, a novel approach is shown for the $BiFeO_3$ system whereby nanoseeds were generated in-situ from the liquid medium by the formation of nanocrystals using a solvent-engineering strategy. Thus, the addition of an antisolvent (1,3-propanediol) to a solution of bismuth and iron salts dissolved in acetic acid resulted in the precipitation of an intermediate compound by supersaturation. The presence of such nanocrystals was confirmed by dynamic light scattering, whereas their permanence in the deposited layer was observed by scanning electron microscopy. The self-induced seeding solutions of this work improved the crystallinity of the corresponding thin films, as demonstrated by X-ray diffraction and piezoresponse force microscopy. Using this low-temperature strategy, crystalline films of $BiFeO_3$ were directly grown on flexible polymeric substrates at only 350 ºC showing a remanent polarization of 10.5 μC cm^{-2} and a clear photovoltaic effect (11.7 μW cm^{-2}). The flexibility of the resulting thin films may enlarge the number of applications of this multifunctional material in next-generation electronic devices based on a facile, large-area and low-cost solution method.



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Referencias

[1] I. Bretos, R. Jiménez, J. Ricote, M.L. Calzada, *Chem. Soc. Rev.*, **2018**, *47*, 291–308.