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Periodic nanostructures obtained by spinodal decomposition at low temperature on $Co_{1.7}Fe_{1.3}O_4$ thin films prepared by radio frequency sputtering

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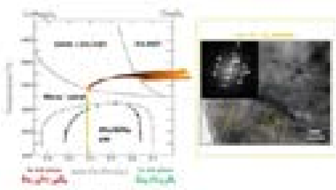
Inside a miscibility gap of a phase diagram, a homogeneous solid solution is not stable and progressively broken down into two different phases either by nucleation/growth or spinodal decomposition. Spinodal transformation which only operates in a limited area of the gap, can induce periodic microstructures at a submicronic scale. When they contain at least a magnetic ordered phase, such microstructures could then be a key step in the quest for materials with original properties such as giant magnetoresistance, and/or magnonic crystal which are likely to find new technological applications. In the $CoFe_2O_4$–Co_3O_4 phase diagram there is a miscibility gap in which spinodal decomposition can lead to regular alternation of ordered magnetic phases made of spinel oxides. This was mainly observed in powders. In the context of potential future applications, it is however necessary to be able to prepare thin films and to induce in them spinodal decomposition at low temperatures. The purpose of this study is devoted to 1) the preparation of $Co_{1.7}Fe_{1.3}O_4$ spinel iron cobaltite thin films on cheap substrate, 2) the structuration at the nanoscale by spinodal transformation at moderate temperatures and 3) the characterization at the nanoscale on the spinodal transformation. Pure thin films of $Co_{1.7}Fe_{1.3}O_4$ spinel iron cobaltites were prepared by rf sputtering. The two-phase spinels obtained through the spinodal transformation were evidenced after annealing in air at low temperature by XRD/TEM/Raman/Mossbauer/electrical measurements studies. Specific in-plane sections elaborated by FIB were carried out and analyzed by high resolution TEM studies coupled with EELS/EDS/STEM elemental analysis at the atomic scale. From the present work it can then be concluded that the preparation of $Co_{1.7}Fe_{1.3}O_4$ thin films structured by spinodal transformation could be obtained at temperatures compatible with the use of cheap substrates.



Biography

A. Barnabé is a professor at the CIRIMAT laboratory (Mixed Oxide Valency research group), Paul Sabatier University, France. He received his PhD degree in chemistry of materials from University de Caen-Basse Normandie (France) in 1999. He held a post-doctoral position in Northwestern University, Evanston (USA), in 2000. His current research interests are mainly focused in functional metal oxide powders, ceramics and thin films prepared by PVD technique. He first worked on TEM characterization of giant magnetoresistance manganites then moves to complex oxides with new optoelectronic properties. For the last decade, he has developed transparent conductive oxides (n- and p-type) and gas-sensing layers for the CO_2 detection sputtered oxide thin films. He's in charge on the SEM/TEM/EPMA/SIMS characterization center R. CASTAING in Toulouse. To date, all these works have led to 63 publications, 2 patents, and more than 80 communications (hindex = 22, sum of the times cited > 1400).

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