Multiferroic properties of particulate composites resulting from combined size effects of the magnetic and ferroelectric phases

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The grain size dependence of the electric properties has been widely studied in piezoelectric materials. At the same way, the magnetic property has been investigated in particles with different sizes. However, in composites containing both piezoelectric and magnetic phase the effect of grain size was not fully explored, including the independent properties of each phase. Even less those that result of combination of two phases, in this case, the magnetoelectric effect.
Aiming to study the dependence of ferroic and multiferroic with average grain size this work reports the electric, magnetic and magnetoelectric properties of particulate composites. The system is compost by the ferroelectric phase 0.675 [$PbMg_{1/3}Nb_{2/3}O_3$] – 0.325 [$PbTiO_3$] (PMN-PT), at the morphotropic phase boundary, and $CoFe_2O_4$ (CFO) as the ferrimagnetic phase. Seeking the control growth of the grain size samples were prepared by Spark Plasma Sintering. The molar proportion used was 80 mol% and 20 mol% for PMN-PT and CFO, respectively. As a result the grain size of prepared samples ranges from hundred nanometers to few micrometers. Therefore, a group of samples with distinct configuration of grain size distribution were obtained and used to study the properties. Room temperature P-E and M-H loops indicate the existence of distinct ferroelectric and ferrimagnetic ordering simultaneously. Besides, were observed that those responses were correlated of grain size. The coupling between magnetic and electric order was confirmed on the magnetoelectric measurement. Particularly, these result showed that the effect of reducing the grain size could induce the self-biased effect, showing an unusual results for particulate composites.