# "Non-conventional magnetoelectric ferroics"


H.T.T. Nong[a], A. Goméz[b], A. N. Nguyen[a], Ch. Ben Osman[c], J. Solard[d], C. Ibrahim[a], N. T. Lan[a], M. Simon Carillo[b] and Silvana Mercone[a*]

a. Laboratoire de Sciences des Procédés et des Matériaux (LSPM-CNRS UPR-3407), Université Paris 13, 93430 Villetaneuse, France

b. Instituto de Ciencia de Materiales de Barcelona (ICMAB-CSIC), Campus UAB, 08193 Bellaterra, España

c. Laboratoire Matière Molle et Chimie, ESPCI, 75005 Paris, France

d. Laboratoire de Physique des Lasers (LPL-CNRS UMR-7538), Université Paris 13, 93430 Villetaneuse, France

* silvana.mercone@univ-paris13.fr ≪corresponding author≫


Multiferroic materials, which possess at least two ferroic properties among ferroelectricity, ferromagnetism and ferroelasticity, are attractive systems due to the possible giant cross coupling between these three orders. In the case of multiferroic magnetoelectric (**ME**) composites, this cross coupling occurs between two ferroics subsystems (magnetic end electric one) and it can give rise to a large direct and/or converse magnetoelectric effect (DME, CME). Indeed, thanks to an efficient DME (CME), it becomes possible to control the dielectric polarization **P** (respectively the magnetization **M**) by a magnetic field **H** (electric field **E**). Thus $\Delta \mathrm{P}=\alpha_{\mathrm{H}}\Delta \mathrm{H}$ ($\mu_0\Delta \mathrm{M}=\alpha_{\mathrm{E}}\Delta \mathrm{E}$) where $\alpha_{\mathrm{H/E}}$ is the coupling coefficient. In the ME composites, showing physically separated magnetic and electric order phases, both DME and CME coupling can be mediated through (a) the strain, (b) the charge carrier and (c) the spin exchange. After a brief introduction of these possible couplings, we will focus on composites materials showing a strain-mediated CME effect. This latter is a product tensor property that results from the elastic coupling between the piezoelectric and magnetostrictive components, which are artificially coupled together in a single composite structure. Several connectivity between the two phases are possible, we report in Figure 1 two of the interfacial bonding we have been studying. The influence of the interface geometries as well as their hybrid nature shown in Figure 1, will be illustrated and discussed both upon the magnetic and the electric properties of the composite nanostructures.

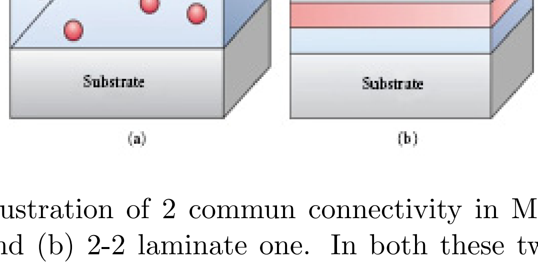


Figure 1: Schematic illustration of 2 commun connectivity in ME composites: (a) 0-3 particulate composite and (b) 2-2 laminate one. In both these two nanostructures, the rose volume corresponds to the ferromagnetic inorganic material while the light blue is the piezoelectric organic one.