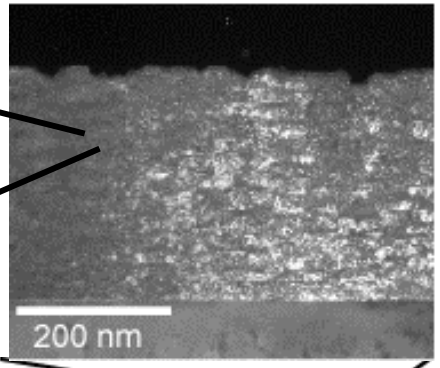
Combinatorial Studies of Metal Oxides, I. Takeuchi, Univ. of Maryland, DMR0094265

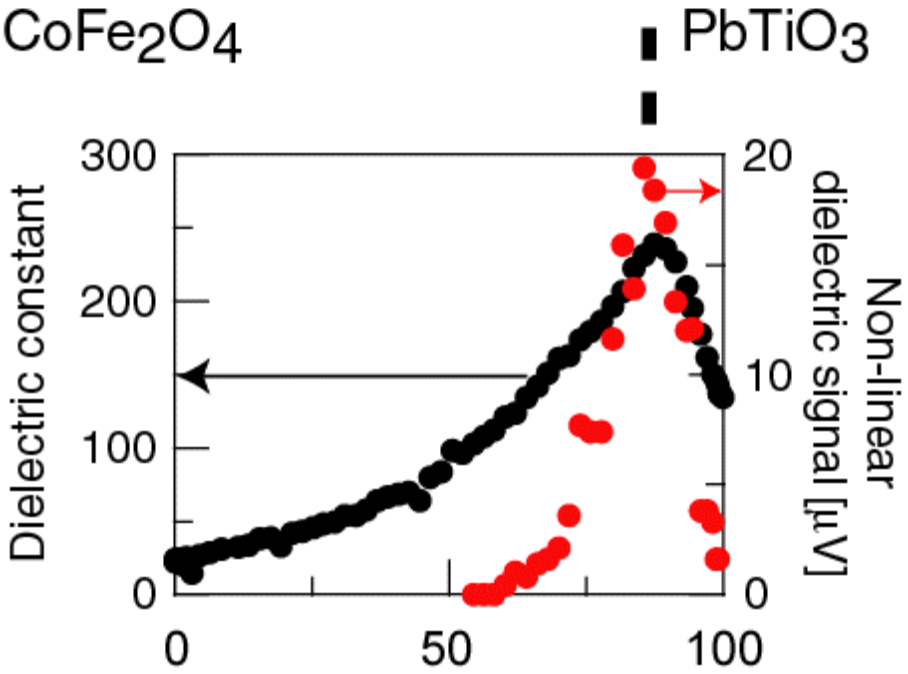


TEM micrograph

$PbTiO_3$ nanopancakes (green) in $CoFe_2O_4$ matrix

We have used a combinatorial synthesis technique called composition spread to design a novel thin film nanocomposite material which is simultaneously ferroelectric and ferromagnetic.

Such multiferroic thin films can be used to fabricate novel sensor and memory devices.



We have used a thin film composition spread to design a multiferroic material (material which is simultaneously ferroelectric and ferromagnetic). The composition spread was used in such a way so that at one end of the spread the composition is purely ferroelectric ($PbTiO_3$), and at the other end the composition is purely ferromagnetic ($CoFe_2O_4$). The idea was to gradually mix the two toward the middle of the spread and study how the two ferroic materials and their properties might “mix”. To our surprise, we found a composition closer to the pure $PbTiO_3$ end which exhibited enhanced ferroelectric properties (Peaks in dielectric properties). This composition was also confirmed to display robust magnetic properties. Upon performing detailed structural studies (high resolution TEM), we found that at this composition, the two materials had arranged themselves in a very interesting configuration: there are epitaxial nanopancakes (~30 nm) of $PbTiO_3$ embedded in the host matrix of $CoFe_2O_4$. We have observed the magnetoelectric effect (coupling of ferroelectricity and ferromagnetism) in this material. This is the first time this effect is observed in a thin film material.

This represents a first step toward realizing a completely new type of sensor, actuator and memory devices.