Magnetoelectric measurements of multiferroic thin film materials using microwave microscopy

ICHIRO TAKEUCHI, University of Maryland,
CHEN GAO, MAKOTO MURAKAMI, KAO-SHUO CHANG, UNIVERSITY OF MARYLAND COLLABORATION — We have developed a technique to quantitatively measure the magnetoelectric (ME) coupling effect in multiferroic materials using microwave microscopy operating at 1 GHz. The technique is used to measure the piezovoltage induced by an external magnetic field through the non-linear dielectric constant. The unique tip geometry of the microscope allows measurement of the ME coupling from a sample region as small as 1 micron cube without the use of a bottom electrode. AC magnetic field up to $\sim 10$ Oe is used. We have demonstrated the measurement on different types of multiferroic films. In particular, PbTiO$_3$-CoFe$_2$O$_4$ nanocomposite thin films consisting of nanograins of PbTiO$_3$ embedded in the matrix CoFe$_2$O$_4$ was found to exhibit enhanced ferroelectric properties and robust ferromagnetism. The ME coefficient as large as $4 \text{ V/cmOe}$ was observed in the nanocomposites at room temperature. Enhancement in the ME effect due to the mechanical resonance of the substrate was observed at $\sim 100$ KHz.

Ichiro Takeuchi
University of Maryland

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