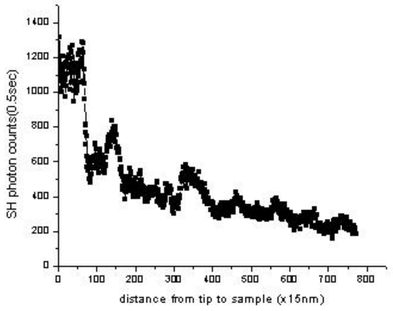
Nano-scale characterization of ferroelectric material using NSOM with half-metal-coated tips

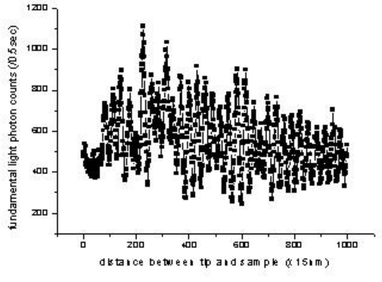
H. Y. Liang, I. I. Smolyaninov/C. C. Davis, C. H. Lee

Objective:

- Ferroelectric materials can sustain spontaneous polarization under Curie temperature. Ferroelectric thin films are widely used in nonvolatile RAM;
- The ultimate performance of FE devices depends on the spatial-temporal properties of individual ferroelectric domains;
- Combination of SHG with NSOM provides a powerful tool to study dynamics of FE domains.



(a)

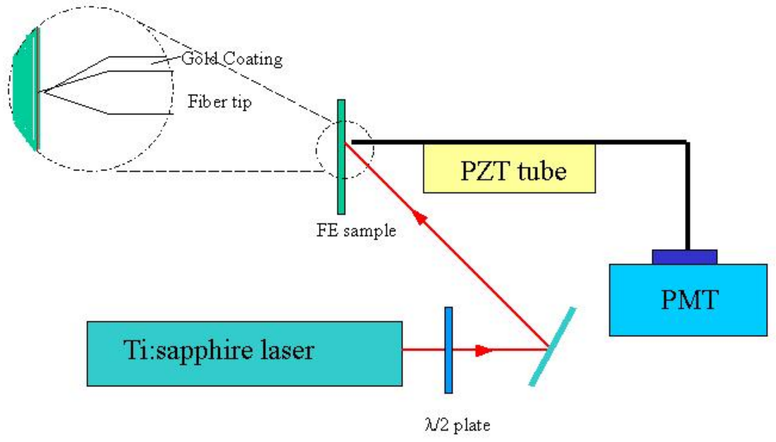


(b)

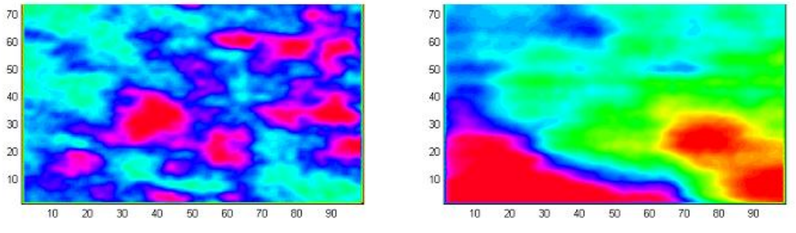
Enhancement of SH at near field of bulk PZT material

(a) photon counts of SH at near field vs. distance between tip and sample;

(b). Fundament photon counts vs. distance between tip and sample.

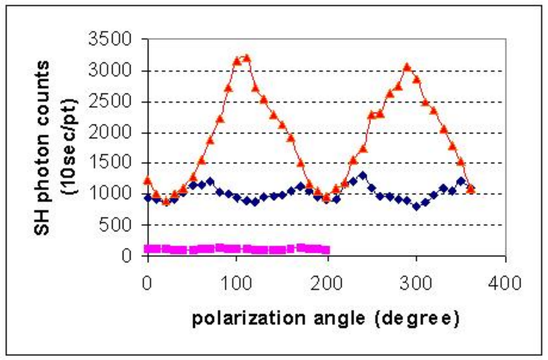


Experimental Setup: Near-field scanning optical microscope (NSOM) with half-metal-coated tip collecting second harmonic (SH) from FE thin film. The use of half-metal-coated tip make it possible to apply electric field normal to the film.

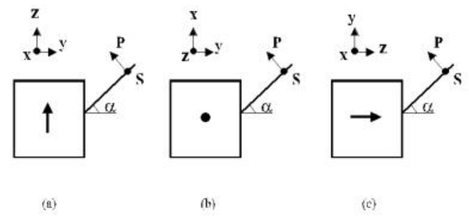


(a) (b)

Simultaneously measured SH near-field optical image (a) and topographical image (b) of a PZT tube. 3 μm by 2 μm images were obtained.



(A)



(B)

(A) Near-field SH signal dependencies on the polarization of fundamental light for three different poling directions of $BaTiO_3$ crystal (shown by the arrows) with respect to the incoming fundamental light (shown by the straight lines). P- and S- polarization directions of the fundamental light are indicated.

(B) Orientation of the $BaTiO_3$ crystal with respect to the illuminating fundamental light for curves (a), (b), and (c) in Fig.3.