Ultra High Density Ferroelectric Data Storage Based on Scanning Nonlinear Dielectric Microscopy

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With the advance of information processing technology, the importance of high-density data storage is increasing. Studies on thermal fluctuation predict that the magnetic storage, which plays a main role in this field, will reach a theoretical limit in the near future, and a novel high-density storage method is required.

Ferroelectrics can hold bit information in the form of a polarization direction. Moreover, the domain wall of typical ferroelectric material is as thin as the order of a few lattices. This feature is favorable for high-density data storage.

Therefore, we have studied the application of ferroelectric materials to high-density storage media. On the other hand, we have developed and reported scanning nonlinear dielectric microscopy (SNDM) for observing ferroelectric polarization distribution[1]. The resolution of this microscopy is sub-nanometer order, which is much higher than other scanning probe microscopy (SPM) methods for observing polarization distribution such as piezoelectric imaging.

In this paper, an investigation for ultra high-density ferroelectric data storage based on SNDM was carried out. For the purpose of obtaining the fundamental knowledge of high-density ferroelectric data storage, several experiments of nano-domain formation in congruent lithium tantalate (CLT) single crystal were conducted. As a result, nano-sized inverted domain dot arrays have been successfully formed at a data density of 1.50 Tbit/inch^2, representing the highest memory density for rewritable data storage reported to date.

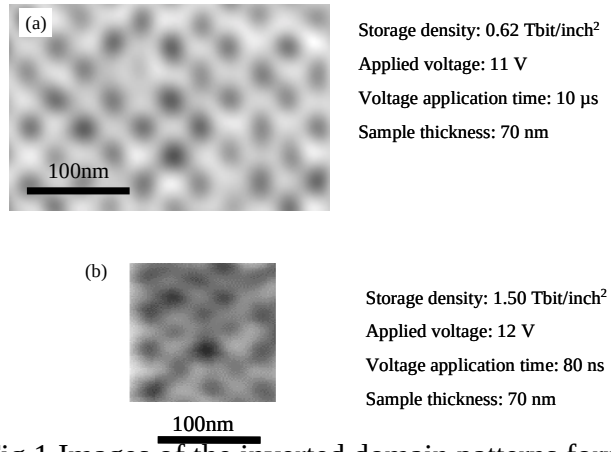

Fig.1 Images of the inverted domain patterns formed in CLT with densities of (a) 0.62 Tbit/inch^2, and (b) 1.50 Tbit/inch^2.

Fig.2 Ferroelecrtic data strage with the density of 717 Gbit/inch^2 in CLT. This figure is composed of 256X256 nano-domain dots with a bit spacing of 30 nm.

[1] Y. Cho, S. Kazuta, K. Matsuura: Appl. Phys. Lett, Vol.72, No.18 (1999),pp.2833-2835 .