【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅰ)

Title of Project : Development of Highly-Functional Scanning Nonlinear Dielectric Microscopy and Its Application to Electronic Devices

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Research Area : Engineering

Keyword : Scanning probe microscopy, Memory, Electronic device・IC, Dielectric

【Purpose and Background of the Research】

The researcher of this project has developed Scanning Nonlinear Dielectric Microscopy (SNDM). This microscopy technique has a world highest resolution and sensitivity in the ferroelectric domain observation and now it has an atomic resolution. In this study, we will develop SNDM with much higher resolution and extend its application area. Using this newly developed SNDM with high performance, we will observe and evaluate the surface of insulator material and also identify the electric dipole moment induced by the absorbed atom. Moreover, we will make the mechanism of atomic resolution appearance in dielectric measurement much clearer. Next, we will develop next generation high density ferroelectric data storage technique based on SNDM. We also study the visualization technique of charges stored in semiconductor electronic device using SNDM. Evolving this technique, we will make a failure analysis in semiconductor device possible, which has been believed to be impossible in capacitance measurement.

【Research Methods】

1. We will develop new SNDM based on the technique detecting higher order nonlinear dielectric constants. Using this newly developed high performance SNDM, we will try to identify atomic species of insulator material. 2. Next, we will develop high speed hard disk type SNDM ferroelectric data storage system with quite high memory density. To do so, we investigate the ferroelectric thin film for the recording medium with large nonlinear dielectric constants. 3. Finally, in the study on the visualization of charges stored in semiconductor device, using the above mentioned newly developed SNDM, we will resolve the electronic structure in the very small new generation semiconductor devices. And also we will apply the SNDM technique to evaluate next generation compound semiconductor device as well as Si devices.

【Expected Research Achievements and Scientific Significance】

The expected research achievements and scientific significance are summarized in Fig.1.

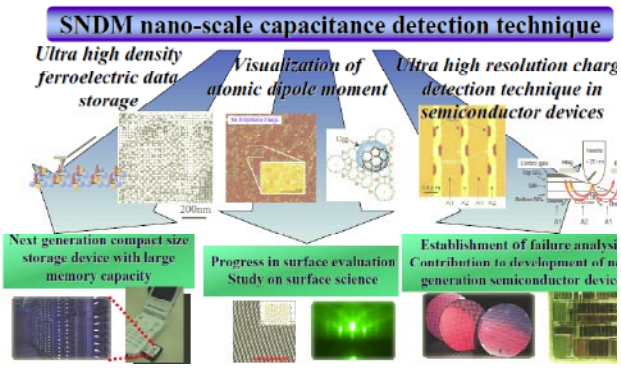

Fig.1 Future perspective -Creation of SNDM Nano Science & Technology-

【Publications Relevant to the Project】

・Yasuo Cho and Ryusuke Hirose: “Atomic Dipole Moment Distribution of Si Atoms on a Si(111)-(7 × 7) Surface Studied Using Noncontact Scanning Nonlinear Dielectric Microscopy”, Physical Review Letters, Vol.99, pp.186101-1-4 (2007).
・Kenkou Tanaka and Yasuo Cho, ”Actual information storage with a recording density of 4 Tbit/in.^{2} in a ferroelectric recording medium” Appl. Phys. Lett,Vol.97, pp.092901-1 -3 (2010).

【Term of Project】 FY2011-2015

【Budget Allocation】 161,800 Thousand Yen

【Homepage Address and Other Contact Information】

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