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Interim Progress Report No. 1 (Week 1 – Lent 2003)

Project Title: **Electrical Transport and Switching in Ferroelectric Thin-Film Oxides**

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Background

Ferroelectric materials exhibit a spontaneous polarisation through the atomic displacement of a body-centred atom in a perovskite (ABO_3) structure with an applied electric field (see Fig. 1). A remnant polarisation is maintained after the removal of the field.

The ability of such materials to switch robustly between one of two stable polarisation states forms the basis of a new approach to data storage. Thin-film ferroelectric perovskite oxides are beginning to see commercial production in high-density (4Mb), very fast (60ns access time) random access memories (RAMs) for non-volatile computer memories (Fig. 2).

Project

Objectives

i. Literature search and evaluation

ii. *Experimental work:* Surface electroding and electrical testing of thin film oxides: Dielectric capacitance, loss and hysteresis measurements on (*initially*) Barium Strontium Titanate films (BST, $Ba_xSr_{1-x}Ti_3$).

Equipment to be used: AixACCT TF Analyzer 2000 test workstation[3]; *Radiant Technologies Precision Premier* material analyser workstation[4]; Hewlett-Packard HP4192A Impedance analyser; Closed-cycle Helium refrigerator and furnace for $30K < T < 650K$ (cryostat / sample stage mounted).

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iii. *Modelling:* Investigation of the model proposed by Cillessen et al. [J. Appl. Phys. **81**, 2777 (1997)] that the apparent ferroelectric thickness dependence of coercive field E_c is not intrinsic, but instead arises from an extremely non-linear resistive layer at the electrode-dielectric interface.

Cillessen's model can be readily tested by varying the temperature T up to the Curie temperature T_c, which has not been previous done. Modelling will require numerical data fitting by computer.

This model was probably first developed by J. G. Simmons [J. Phys. Chem. Sol. **32**, 1987 (1971); **32**, 2581 (1971); J. Appl. Phys. **38**, 832 (1967)] but has been rediscovered without citation and perhaps misapplied by Cillessen et al.

Figure 1. [Right]

A perovskite structure and associated hysteresis loop

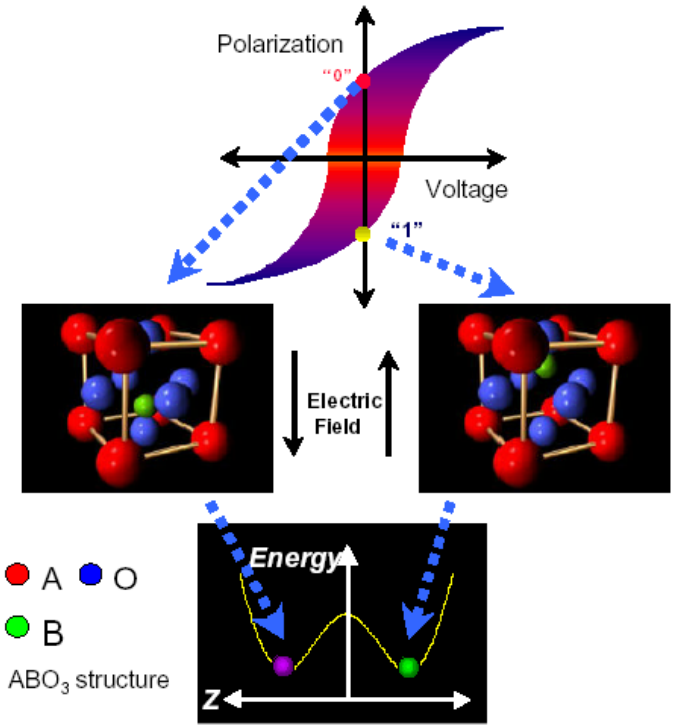

Figure 2. [Below]

A chip photograph of SEC's 4Mb 1T1C COB Ferroelectric RAM

(Source: Samsung Electronics)