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Interim Progress Report No. 2 (Week 8 – Lent 2003)

Project Title: **Electrical Transport and Switching in Ferroelectric Thin-Film Oxides [subject to change]**

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Summary

Experimental work

Approximately two hundred hours have been spent preparing and electrically characterising sections of a single high quality 4” Barium Strontium Titanate $Ba_{0.7}Sr_{0.3}TiO_3$ (70/30 composition) 175nm thin film wafer, produced in Aachen Germany, by Chemical Solution Deposition, from which approximately fifteen segments have been cleaved by physical scoring and direct fracture. The wafer consists of an apparent silicon substrate, with a platinum bottom electrode (verified by XRD), and no top electrode [Si – SiO_2 – Pt – BST]. 1mm diameter or larger ex-situ gold top electrodes were deposited by gold sputtering, in four repeated 3-minute depositions, using a metal contact mask, to allow twice-through (top to top) electrical contact of samples.

Severe difficulties were experienced in electrically contacting the samples through the sputtered contacts using spring-mounted needles either within the cryostat or on a sample stage (where the needles could be precisely controlled). Silver paint was applied directly between the Au contacts and needles, to encourage better electrical contact. The failure rate with obtaining proper contact was intolerably high with spring-mounted contacts. This was marginally improved by the use of wire-bonding by hand, and encasing samples in a supportive putty matrix to reduce stress on the wire-bonds.

SEM analysis of a wafer segment reveals the appearance of random but generally homogeneous pinhole shorts in the BST layer, which would readily account for the observed hysteresis distortions and electrical shorts between some widely separated contact pairs. It has been possible, however, to obtain on average one satisfactory pair of surface contacts in a sample containing 48 contacts or fewer.

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A wide range of sensible data has been obtained from the wafer, albeit not from the sample segments, due to the degeneration of contact quality during temperature cycling / vacuum pumping. The nature of the data acquisition has also made it difficult to readily record data. Some evidence has been obtained to indicate the presence of a (potentially rate independent) phase transition hysteresis on cooling and warming of the samples (see below), between room temperature and approximately 33K, under vacuum. There is also good evidence from hysteresis, remnant hysteresis, I/V, leakage and C/V at discrete temperatures, to partially support what has been observed in capacitance-temperature measurements.

Further data from the samples of polarisation-temperature (hysteresis) should clarify the observations made from C-T immediately. The result of XRD at various discrete temperatures is also expected shortly.

It remains unclear at this time as to whether there is sufficient data to comment on the model proposed by *Cillessen et al*. Further data mining and laboratory time is required.