NEW MATERIALS AND STRUCTURES FOR GAS SENSORS

ELECTRON PHYSICS LABORATORY

Solid-state chemical sensors based on metal oxides are the most promising gas detectors due to their small size, low cost, good sensitivity, and compatibility with microelectronic processing techniques. However, the gas sensors made of thick film or sputtered polycrystalline films have problems with long-term stability due to the porous nature of the sensing layers and a large amount of grain boundaries. These problems can be overcome by growing good quality or nearly epitaxial thin films of metal oxides. If the films are thin enough, one can get stable and sensitive thin films.

RECENT RESULTS

We have grown 30-100 nm thick high quality SnO_2 thin films on r-axis sapphire substrate with Molecular Beam Epitaxy (MBE) in the temperature range 400-700 ^{0}C. An e-beam evaporator and RF-plasma cell have been used as the tin and oxygen sources, respectively. In-situ Reflection High Energy Electron Diffraction (RHEED) pattern shown in Fig. 1 confirms the nearly monocrystalline structure of the grown films. The crystal quality has also been examined with X-ray diffraction. For the gas response studies Pt electrodes have been deposited on top of the tin dioxide films. Sensitivity to various gases in dry synthetic air has been tested, and the results (see Fig.2) allow us to optimize further the properties of the gas sensing films.

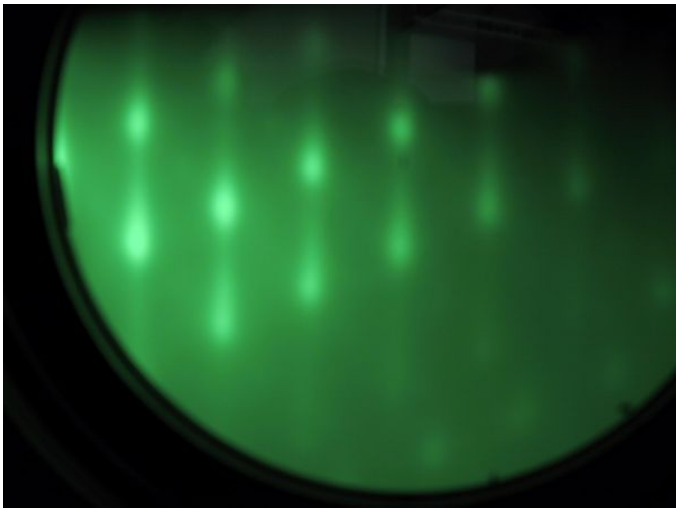

Figure 1: The RHEED pattern of a 30 nm thick SnO_2 thin film grown on a sapphire substrate. The pattern is formed on a phosphor screen by an electron beam striking the substrate surface at a small angle. The diffraction pattern reveals details of the crystalline structure of the sample.

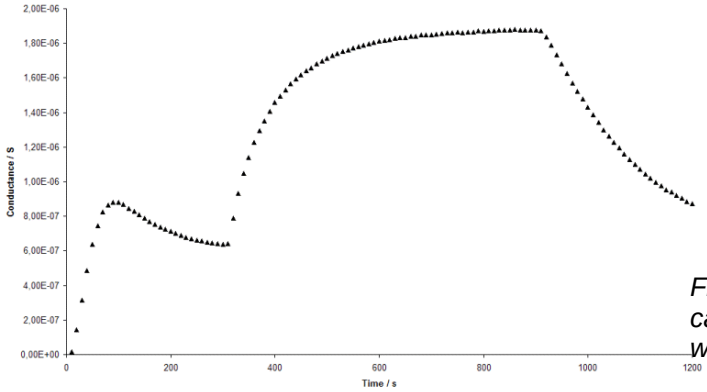

Figure 2: Measured conductivity change in the case of a high quality 100 nm tin dioxide thin film when exposed to 1000 ppm H_2 in N_2 at 400 ^{0}C.

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Recent Publications

1. S.Saukko, U.Lassi, V.Lantto, M.Kroneld, S.Novikov, P.Kuivalainen, T.T.Rantala, and J.Miszei: ”Experimental studies of O2-SnO2 surface interaction using powder, thick film, and monocrystalline thin films”. (Accepted for publishing in Thin Solid Films 2005).

2. M.Kroneld: “Gas sensing properties of mono- and polycrystalline tin dioxide thin films grown by MBE”. Licentiate thesis, HUT 2005.