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Characterization of Undoped a-Si:H by Charge Deep-Level Transient Spectroscopy

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The deep level transient spectroscopy (DLTS) is a powerful method for the identification of deep levels in semiconductors. However, the assumption of the original capacitance DLTS[1] is that the processes of carrier capture at and emission from the gap states within the depletion region can be monitored through the changes of the depletion region capacitance. This, of course, limits the application of the capacitance DLTS to relatively conductive materials. However, there is a considerable interest in the electrical characterization of high resistivity materials such as undoped hydrogenated amorphous silicon (a-Si:H), high purity crystalline silicon, semi-insulating GaAs, fullerenes, organic thin films, etc. In order to utilize the advantages of the DLTS for these materials as well, a novel version of the charge DLTS (QDLTS) had been proposed[2]. Subsequently QDLTS yielded valuable results when applied to semi-insulating GaAs[3], Langmuir-Blodget films[4] and C60 single crystals[5].
According to our knowledge, here we present the results of first QDLTS measurements on undoped a-Si:H. Metal/insulator/semiconductor (MIS) structures were prepared in order to minimize the leakage current. Our measurements demonstrate that the saturated QDLTS signal is proportional to the thickness of a-Si:H layer. Two distinct QDLTS features were observed, A and B. Fitting procedures show that they correspond to deep defects with energy levels of 0.65 eV (A) and 0.97 eV (B) below the conduction band edge. We have convincing experimental evidence for deep defect relaxation processes in a-Si:H. If a sample in state B is annealed under certain bias at consecutively higher temperatures, it gradually relaxes to state A.

(1) D.V. Lang, J. Appl. Phys. 45 (1974) 3023.
(2) I. Thurzo et al., Meas. Sci. Technol. 7 (1992) 516.
(3) I. Thurzo et al., Nucl. Instr. Meth. Phys. Res. B 8 (1993) 145.
(4) D. Barancok et al., Thin Solid Films 243 (1994) 463.
(5) D. Barancok et al., Solid State Commun. 89 (1994) 123.

Figure captions:

Fig. 1 QDLTS spectra for different thicknesses of a-Si:H films: 1 - 30 nm, 2 - 100 nm, 3 - 300 nm

Fig. 2 QDLTS spectra of a-Si:H sample being in different states.

Fig. 3 QDLTS measurements of relaxation processes in a-Si:H.