A Novel Approach to Compact Model Parameter Extraction for Excimer Laser Annealed Complementary Thin Film Transistors

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Excimer laser annealing technique has recently been proposed in the fabrication of lower temperature polycrystalline silicon (LPTS) thin film transistors (TFTs), in particular for applications to an active-matrix liquid crystal display (AMLCD) [1] and system on panel (SOP). The laser annealed polycrystalline silicon has relatively larger grain size and exhibits the higher electron-hole mobility than that of conventional ones. Therefore, the embedded driving circuit could be easily achieved for replacing the additional driving integration circuits (ICs) in LCD's. It is known that an equivalent circuit model, such as RPI TFT model, significantly plays an important role in the design of the embedded driving circuit using laser annealed LTPS TFTs. Any computationally effective extraction techniques must benefit the semiconductor display industry [2]. Unfortunately, it still lacks a robust and accurate optimization procedure which is feasible to extract RPI TFT model's parameters as far as we know.

In this paper, a physical-based model parameter extraction technique [2] for excimer leaser annealed LPTS TFTs is proposed. Comparison between the measurement and simulation results shows that the proposed method exhibits very good accuracy and robustness with respect to the widely used RPI model and its variants. Several electrical characteristics of n-type laser annealed LTPS TFT, such as I_{DS}-V_{GS}, I_{DS}-V_{DS}, trans-conductance (G_m), and output conductance (G_{ds}) are accurately simulated and calculated with the different two models, the RPI TFT V1 and V2 models, respectively. The proposed extraction procedure is suitable for the circuit simulation of both n- and p-type laser annealed LTPS TFTs with the well-known RPI TFT V1 and V2 models. Our extraction procedure consists of the following steps: (1) a set of characterized mobility parameters is extracted in the linear region of I_{DS}-V_{GS} curves; (2) the sub-threshold regions of the I_{DS}-V_{GS} curves is extracted by selecting the threshold and flat band parameters; (3) by choosing the saturation and the kink effect parameters, the saturation region of the I_{DS}-V_{DS} curves is extracted; and (4) the leakage region of the I_{DS}-V_{GS} in log scale is extracted. Extraction results of an n-type laser annealed LTPS TFT (length = 12 um, width = 4 um, and oxide thickness = 100 nm) are shown in Figs. 1 and 2, respectively. After our optimization process, it is found that both RPI V1 and V2 model have potentially very good agreement with the measurement. The improvement of the V2 model is mainly for the accuracy of the G_m and G_{ds} curves.

A physical-based model parameter extraction method for LTPS TFTs has been successfully developed. By considering the RPI TFT V1 and V2 models, we have verified and compared the simulation results with the measured data. The results of I_{DS}-V_{GS} and I_{DS}-V_{DS}, shown in Figs. 1 and 2, are with 3% maximum RMS error for all quantities. This extraction technique provides a novel alternative in developing display ECAD tool and is useful in complementary SOP circuit simulation.

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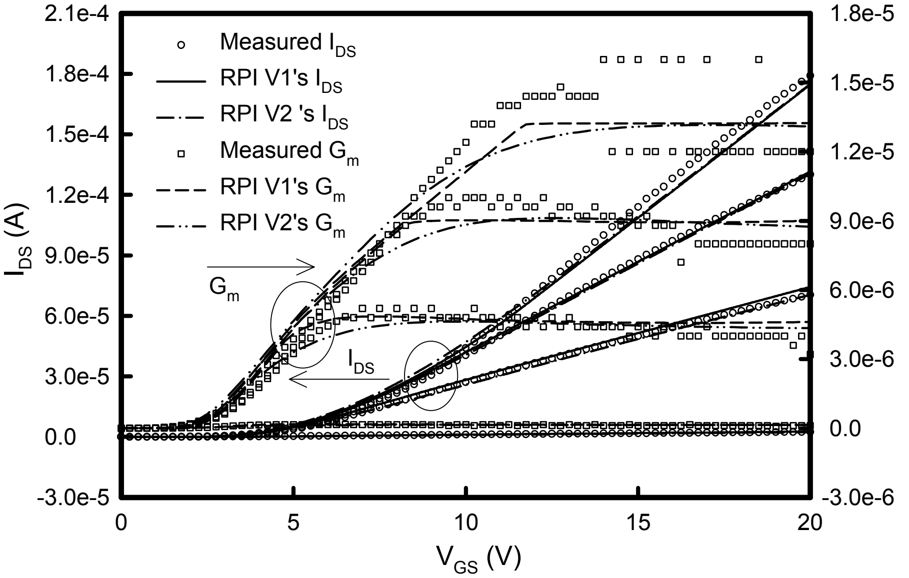

Figure 1: The I_{DS}-V_{GS} and G_m obtained from the quasi-static measurement, and the simulation of RPI V1 and V2 models, respectively. The V2 model is accurate in the G_m curves.

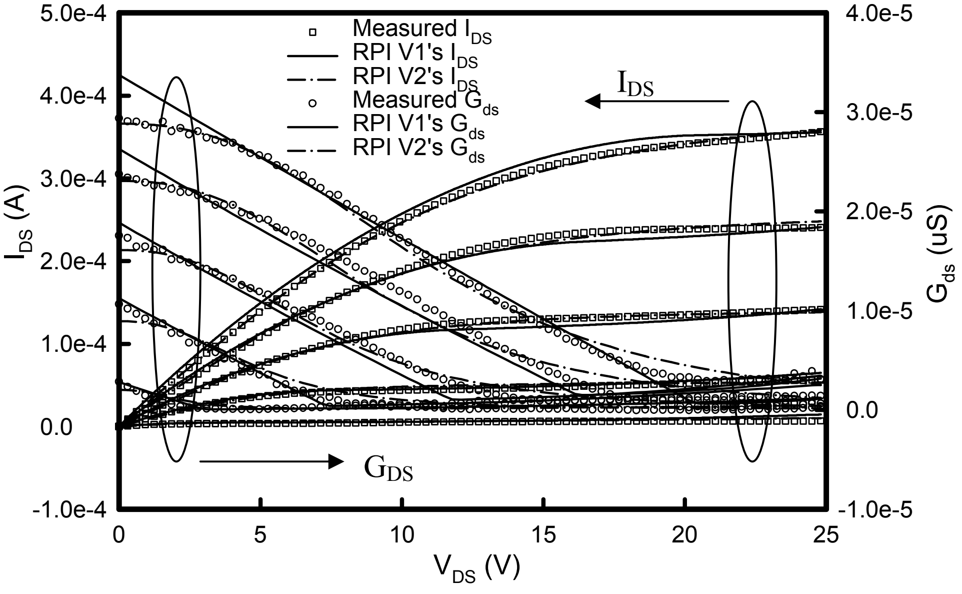

Figure 2: The obtained I_{DS}-V_{DS} and G_{DS} characteristics, the V2 model is accurate in the G_{DS} curves.

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