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An investigation of the electrically active defects in poly-Si Thin Film Transistors

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Polysilicon thin-film-transistors (TFT) are key building blocks for active-matrix-driven flat panel displays. The quality of a poly-Si film can be described as a function of the grain size, the defect density within the grain and the grain boundary and the uniformity of the microstructure over a large area. The aforementioned characteristic parameters are strongly affected by the crystallization process. Despite the necessary among the material quality, uniformity and process throughput, laser crystallization is the only technology with the ability to produce very high quality polycrystalline films.

Recently, polycrystalline silicon films have been obtained by means of the sequential lateral solidification (SLS) method [1]. This method allowed the formation of large and directional, almost continuous, grains (fig.1) leading to a high quality material. Transistors with channel orientation parallel to the grains exhibited carrier mobility of about 300cm^2/Vsec.

The transistors, used in the present work, were fabricated by laser re-crystallization according to the process described in Ref.1. The transistor channel orientation was in the direction of crystallization (fig.1). The assessment was performed by means of deep level transient spectroscopy (DLTS) method. Since TFTs are floating body devices, they are prone to drain current overshoot transients that arise from generation-recombination process [2]. N-channel devices with an intrinsic active region of W =8 μm and L=8 μm were used. The oxide thickness was 100 nm and the polysilicon film was 50 nm. The DLTS measurements were performed in the linear region of operation (V_{DS}=50mV) and in the temperature range of 200K to 400K. The experiments were repeated under white light illumination. Under dark and temperature range from 260K to 400K, the spectra were found to be complex (fig.2) indicating a continuous contribution from generation-recombination centers, evidence of a rather high quality material. This was confirmed by respective DLTS spectra under illumination where the generation process was continuous. At lower temperatures the generation lifetime increased significantly not allowing the drain current transients to follow the repeated process of the DLTS assessment.

In order to, further, investigate the material quality, the devices were subjected to hot carrier stress. The stress bias levels were chosen to achieve the worst case conditions, that is $V_G=V_D/2$. This condition leads to the maximum carrier injection into gate-oxide. The threshold voltage shift is presented in Fig.3. The material degradation and its effect on the generation-recombination mechanism were assessed with the DLTS method successively at 10^3, 10^4 and 10^5 sec.

REFERENCES

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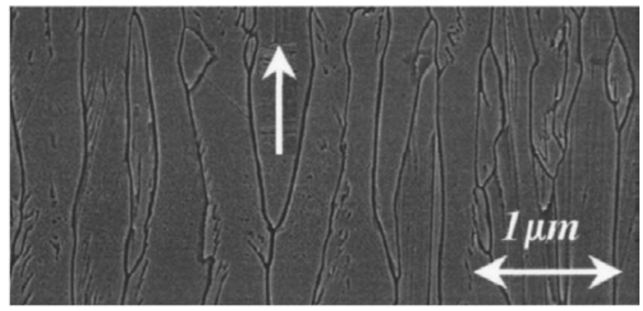

Fig.1 SEM image of directionally solidified poly-Si film. The arrow indicates the direction of TFTs channel.

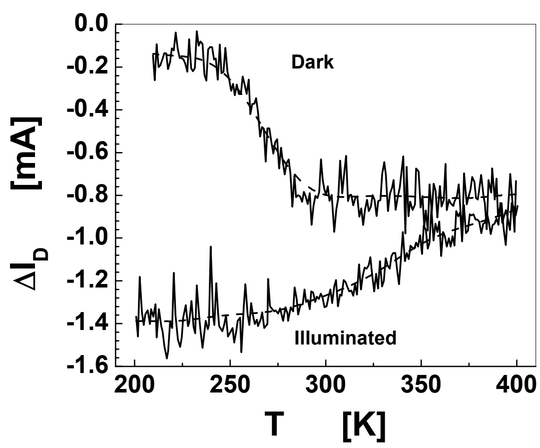

Fig.2 DLTS spectra of SLS TFT under dark and continuous illumination.

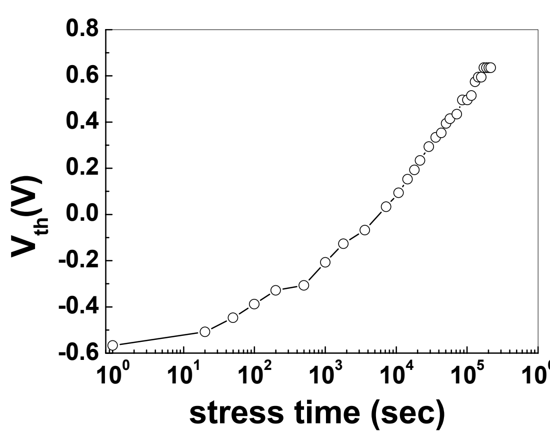

Fig.3 Threshold voltage shift of a TFT subjected to hot carrier stress ($V_G=V_D/2$, V_D=14Volt)