ELA poly-Si TFTs for advanced Flat Panel Imagers

J.P. Lu, J. Ho, Y. Wang, K. Van Schuylenbergh, C.W. Shih and R. A. Street
Palo Alto Research Center
3333 Coyote Hill Rd., Palo Alto, CA 94304

Flat Panel Imagers (FPIs) have become an increasingly important application of large-area thin-film transistors (TFTs) beside flat panel displays. Commercially available flat panel imagers, resembling closely to typical active-matrix-addressed LCD displays, are simple arrays of photo sensors connected to active matrix switching networks built on amorphous Si (a-Si) TFTs. The fast maturing Excimer Laser Annealed (ELA), poly-Si TFT technology provides the possibility of incorporating some long sought capabilities such as integrated gate line drivers, data line multiplexers, and pixel level pre-amplifiers because of the much higher TFT performance compared to standard a-Si TFTs. Pixel level pre-amplifiers are particular interesting for FPI application because they potentially enable a level of sensitivity that will be very difficult to achieve with conventional FPI structure.

We have successfully optimized the ELA poly-Si TFT technology to achieve low off-state leakage current (2fA/µm) such that it can be used in the FPI application. Figure 1 shows the typical TFT transfer characteristic of both n-channel and p-channel devices. Experimental FPIs using conventional single-transistor, pixel switch structure has been realized to test the uniformity and feasibility of applying poly-Si TFTs in FPIs. In addtion, we have successfully incorporated integrated gate-line drivers, built together with poly-Si TFTs used in the pixel arrays.

We have also successfully demonstrated advanced FPIs with integrated pixel-level pre-amplifiers. As the read-out noise scaled proportionally to the data line capacitance in conventional FPI structure, noise magnitude scaled with panel size as well and becomes a real limitation for realistic size FPIs. Pixel level pre-amplifiers fundamentally relieve this limitation. It also enables advanced readout sequence such that the theoretical lower limit of noise amplitude associated with reset process can be overcome. Two types prototype FPIs with pixel-level pre-amplifiers have been demonstrated. The first one is a 384x256 pixels prototype, whose every pixel has a single transistor source follower amplifier, with the other two TFTs for pixel selection and photosensor reset. The second type is a 128x128 array of complete two-stage charge amplifiers, where each pixels use a total of five TFTs, including both n-channel and p-channel device. Both type of prototype FPIs have satisfactory linearity and uniformity. Good noise performances of 830eRMS and 1900eRMS have been achieved for the two types of FPIs respectively.

In this talk, we will summarize our effort of adopting ELA poly-Si TFT technology for the application of FPIs, as well as report the most recent progress of implementing the second type of advanced FPIs with complete charge amplifier in each pixel. TFT requirements and their relation to the noise performance will also be discussed.

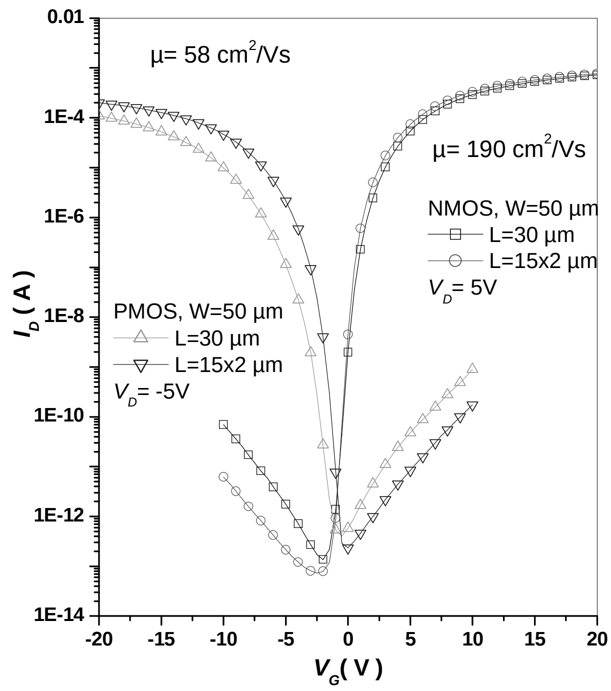

Figure 1 Typical transfer characteristic of the optimised ELA poly-Si TFTs. Note that less than 0.1pA can be achieved for 50µm wide device at V_{DS}=5V.

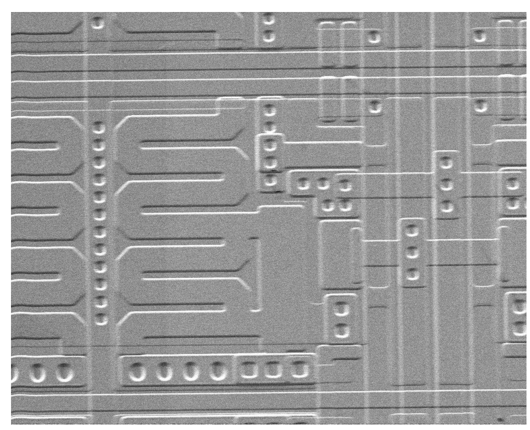

Figure 2 SEM micrograph of the pixel structure of a 128x128 array of five transistor 2-stage charge amplifiers

Figure 3 Image captured by the prototype FPI shown in Fig.2.