

Representative Flicker Noise Measurements For Low-Temperature Amorphous Silicon, Organic and Zinc Oxide Thin-Film Transistors

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To robustly acquire signals from physically-large and distributed thin-film sensing arrays, systems are beginning to explore the use of local instrumentation circuits implemented using Thin-Film Transistors (TFTs). Through local amplification close to sensors, signal-to-noise ratio can be maximized at physically-distant computational and data-conversion units (e.g. within CMOS ICs). Given the low frequencies of interest in typical sensing applications, the 1/f (flicker) noise properties of the TFTs are of importance. In this abstract we will present representative examples of 1/f noise measurements in three different low-temperature-processed TFT technologies: amorphous silicon (a-Si), organics, and metal oxides.

TFTs are fabricated in-house in these technologies. Amorphous-silicon TFTs are fabricated with a silicon nitride gate dielectric deposited by PECVD [1]; organic TFTs based on dinaphtho[2,3-*b*:2',3'-*f*]thieno[3,2-*b*]thiophene (DNNT) are fabricated with a parylene gate dielectric deposited by evaporation; and metal oxide TFTs based of zinc oxide are fabricated with an aluminium-oxide gate dielectric grown by PEALD [2]. All layers for the transistors are processed at temperatures lower than 200 degrees Celsius. Drain-current noise in the TFTs is characterized using an Agilent E5052B Signal Source Analyzer for different width transistors and under different bias conditions.

Though the physical origin of flicker noise has been attributed to a range of sources, including mobility fluctuations, fluctuations in number of carriers in the channel (as a result of interface traps), etc., it is known that 1/f noise can be reduced through area-scaling, which is shown in both our a-Si and ZnO TFTs in Fig. 1. Due to differences in their electrical characteristics, TFTs in the various technologies impact circuit metrics (such as SNR and area) differently with respect to 1/f noise levels. We thus input refer the noise levels measured and normalize to the transistor area (width×length). The resulting metric is representative of SNR at a given area, with g_m representing the small-signal transistor gain and S_{id} the noise power-spectral density at the output. Typical results are shown in Fig. 2; ZnO TFTs perform favourably with this metric as a result of their high transconductance (high mobility).

1. W. Rieutort-Louis et al., *Materials Research Society Spring Meeting*, Paper K4.3 (2012).
2. Y. Afsar et al., *ITC Technical Digest*, p. 86 (2014).

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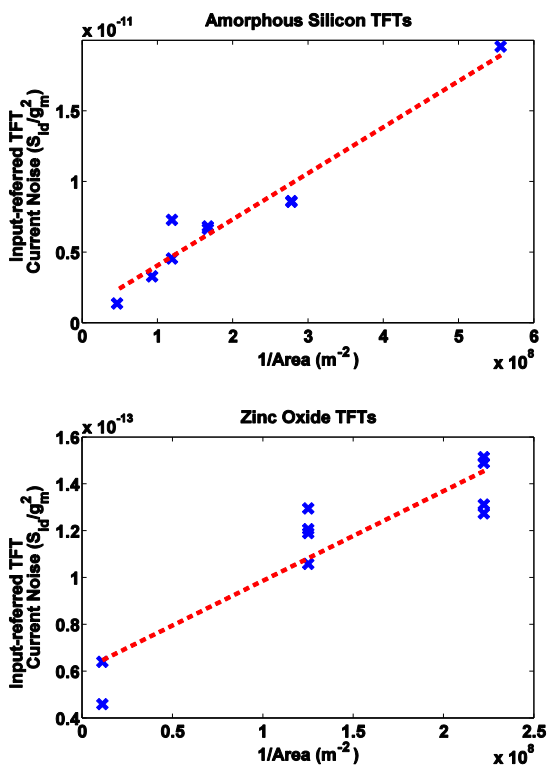


Fig. 1: Area-scaling of 1/f noise in a-Si (top) / ZnO (bottom) TFTs (markers represent different measured TFTs)

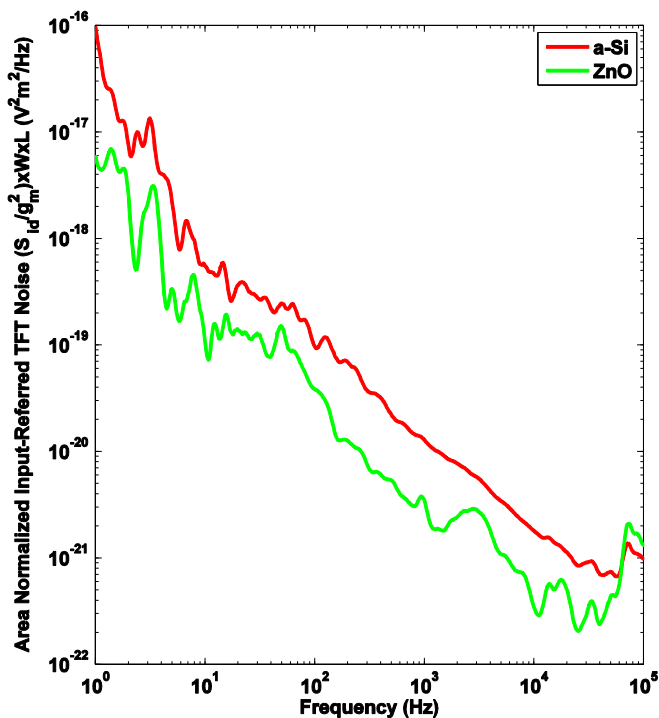


Fig. 2: Representative examples of TFT current noise for a-Si/ metal oxide TFTs