EFFECTS OF X-RAY IRRADIATION ON THE NOISE BEHAVIOR OF LOW-TEMPERATURE POLYCRYSTALLINE SILICON TFTS

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X-ray active pixel sensor (APS) has attracted great attention because of higher signal to noise ratio (SNR) by amplifying the signal in pixels. Each APS circuit contains the X-ray detector and a-Si thin film transistors (TFTs). Due to the high mobility, low-temperature polycrystalline- silicon (LTPS) TFTs have been proposed as a suitable candidate to replace the a-Si TFT. Previous research revealed that the significant transfer curve change under X-ray irradiation can be observed. However, the effects and reliability of X-ray irradiation on the low frequency noise (LFN) are rarely discussed. In order to find out the noise behavior of LTPS TFTs under X-ray, we investigate the noise spectrum density of the LTPS TFTs under irradiation conditions in this paper.

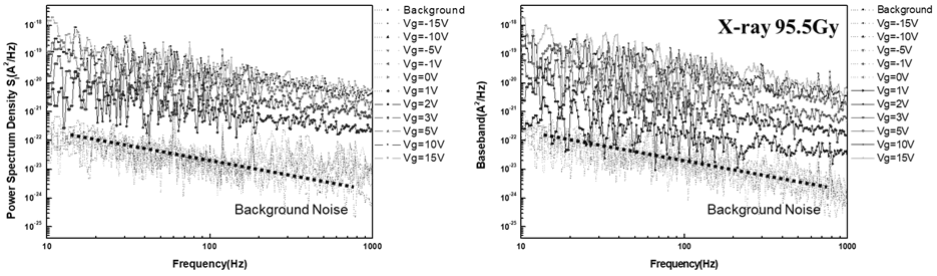

Figure 1 –Power spectrum density of LTPS TFTs measured at different V_G from -15 to 15 V and a constant V_D of 9 V (a) in dark and (b) after X-ray of 95.5mGy

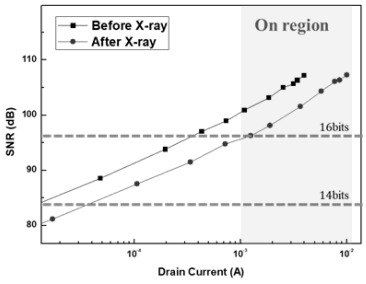

Figure 3 –The curves of SNR in dB scale versus I_D in logarithm scale for the LTPS TFTs before and after X-ray irradiation

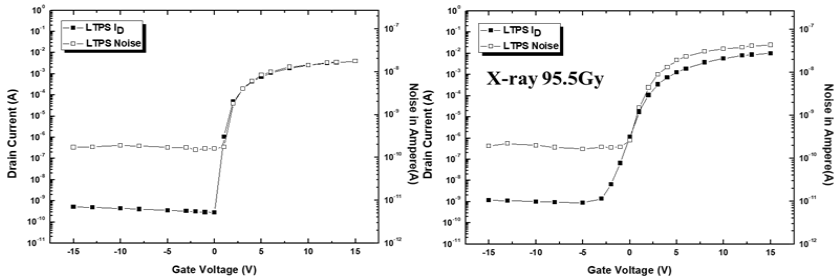

Figure 2 –Dependences of ID and NiA on VG for the LTPS TFTs (a) in dark and (b) after X-ray of 95.5mGy

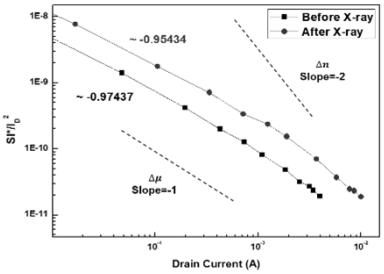

Figure 4 –The curves of S_I*/I_D^2 versus I_D for the LTPS TFTs before and after X-ray irradiation

The results of LFN power spectrum density (S_I) versus the frequency (f) measured with and without X-ray irradiation are shown in Fig. 1(a) and 1(b). The results indicated that the level of power spectrum density move upward with the irradiation. And then, we try to analyze the LFN behavior in another approach by using NiA, which is an index to represent the noise in ampere in our previous paper [1], as shown in Fig. 2(a) and 2(b). In the APS application, the best SNR which a TFT can provide is expected as the ratio of signal power to the noise power. Therefore, Fig. 3 shows the SNR in dB scale versus log (I_D). We can observe that SNR after X-ray irradiation decreases by 5dB. Besides, The normalized noise power spectrum integral S_I*/I_D^2 versus I_D before and after X-ray irradiation are plotted in Fig. 4. The slopes of the curves are around -0.97 and -0.95, which is more close to -1 for the model of mobility fluctuation. It is further revealed that the noise mechanism under X-ray is attributed to mobility fluctuation [2].

[1] Y. H. Tai, et al. “Dependence of the noise behavior on the drain current for thin film transistors,” IEEE Electron Device Letters, vol. 35, no. 2, pp. 229-231, 2014
[2] F. N. Hooge , et al. “Amplitude distribution of 1/f noise,” *Physica*, vol. 42, no. 3, pp. 331–339, 1969