MICC Poly-Si TFTs on Stainless Foil for Flexible Display

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We studied the fabrication of the high performance poly-Si thin-film transistor (TFT) on a 100 μm-thick stainless-steel (SS) foil for flexible displays. The poly-Si film was crystallized by metal-inducing crystallization of amorphous silicon through a SiN_x cap layer (MICC).[1, 2, 3] The MICC technique has many advantages as shown in Table 1: The a-Si surface is clean during the crystallization because the cap layer protects the surface and the SiN_x/a-Si on substrate is used for thermal process. Therefore, the role of cap layer on a-Si is the control of the nickel concentration for inducing crystallization as well as the passivation layer during thermal process.

Ni density of 1.5×10^{14} atoms/cm^2 was deposited on a SiN_x cap by sputtering. Figure 1 shows the schematic diagram of a Ni/SiN_x/a-Si/buffer/SS structure for crystallization.

The 100×100 mm^2 sample was crystallized by two-step annealing process: Samples were heated at first 630 ℃ for crystallization and then heated at 900 ℃ for recrystallization. Although the thermal expansion coefficients between the SiO_2, the poly-Si film and SS are different[4], this sample on SS does not show any crack or strip.

Figure 2 shows the optical microscopy images of the disk-shaped grains taken as a function of RTA cycle. The a-Si was heated in a pulsed RTA at 630 ℃ for 5 min with various cycles of (a) 1;(b) 2; and (c) 4.

The crystallization of amorphous silicon begins from the $NiSi_2$ crystallites formed by the diffusion of Ni atoms through the silicon-nitride cap layer and disk-like grains can be grown by the lateral crystallization from the seeds. From Fig. 2(c), the size of disk-shaped grain was above 10 μm.

Figure 3 shows the transfer characteristics of MICC poly-Si TFTs on SS. The TFT exhibited the field-effect mobility of 75.0 cm^2/Vs and the threshold voltage of -3.9 V and the on/off current ratio of 10^6.

The MICC technique on SS, as a powerful technique for solid phase crystallization of amorphous silicon, can be used for low cost and large-area flexible displays such as AMOLED.

Reference

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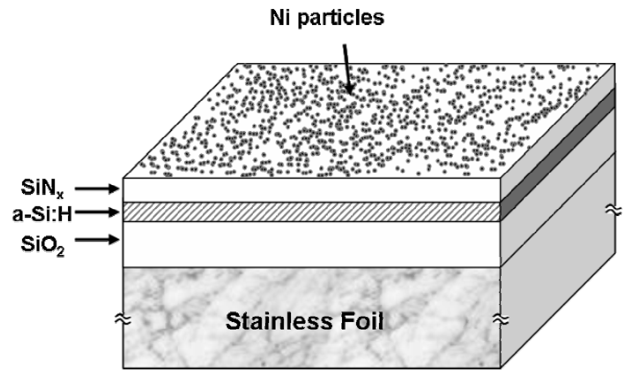

Fig. 1. A schematic diagram of Ni/SiN_x (50 nm)/a-Si:H (100 nm)/SiO_2 (1 μm)/SS (100 μm) for MICC.

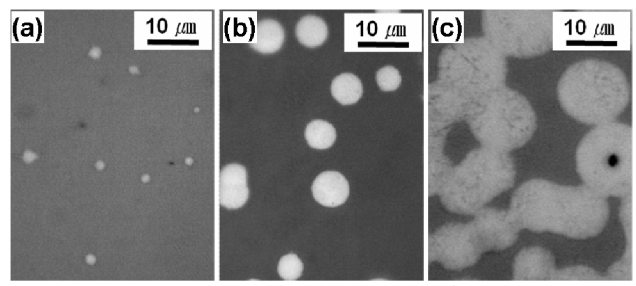

Fig. 2 The optical microscopy images of the disk-shaped grains taken as a function of RTA cycle. The a-Si on SS was heated in a pulsed RTA at 630 ℃ for 5 min duration, with various cycles of (a) 1;(b) 2; and (c) 4. The Ni area density on SiN_x cap was 1.5×10^{14} atoms/cm^2.

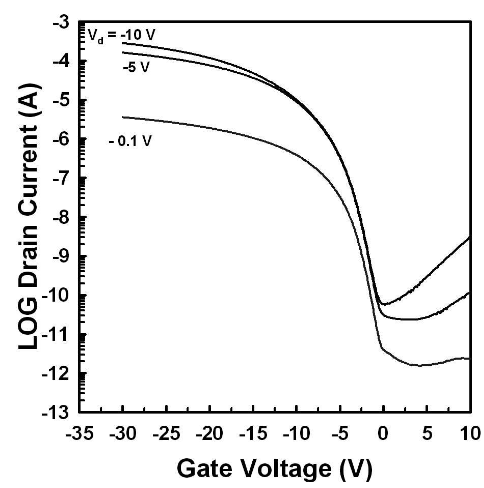

Fig. 3. The transfer characteristics of a MICC poly-Si TFT on SS with W/L=8 μm/8 μm.

Table 1. Comparison of conventional MIC with MICC.

Conventional MIC	MICC
- Surface contamination during thermal process. - Contamination of metal and other impurities on the surface. - Non-uniformity metal particles over the surface.	- Low metal contamination (Impurities can be filtered) - No contamination of poly-Si surface during thermal pr ocess. - Clean and smooth surface.