Electrical characteristics of a-Si:H TFTs under bending stresses

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Recently, bendable thin-film transistors (TFTs) have attracted much attention as one of essential components for bendable display[1,2]. Especially, a-Si:H TFTs used as driving devices for organic light-emitting diode (OLED) have been intensively studied in order to realize high performance OLED even under bending stresses[3]. However, up to now, there is a lack of researches on the effect of TFT channel dimensions on the electrical characteristics under bending strain. Hence, in this study, we investigate the effect of the channel dimension on the electrical characteristics as TFTs are bent.

In this study, n-type a-Si:H TFTs were fabricated on 25-μm-thick polyimide substrates as shown in Fig. 1(a). The channel widths varied from 8 to 50 μm and the channel lengths were 10 μm. The TFTs were bent using homemade bending stages as depicted in Fig. 1(b) and the electrical characteristics were examined using an HP 4155C semiconductor analyzer. For compressively strained TFTs, the electrical measurements were performed at bending radii more than 2 mm because of limit of measurement. And we categorized the operation regions dependent on mechanical strain on the basis of the shift of the threshold voltage. In addition, we examined the mechanical stability of a wide channel TFT by a bending cycle test at a bending radius of 12 mm.

The effect of the channel dimension on the electrical characteristics appears remarkably under tensile strain rather than under compressive strain as shown in Fig. 2(a). Based on our bending study, the operation of TFTs can be divided into safe, transition, and definitive mechanical failure regions as exhibited in Fig. 2(b). The safe and transition regions are divided by criterion of a threshold voltage shift of 1 V. For a channel width of 50 μm, the TFT operates safely under bending with a compressive radius of 3 mm and a tensile radius of 4 mm. Furthermore, the TFT with a channel width of 50 μm operates stably even after 10000 bending cycles.

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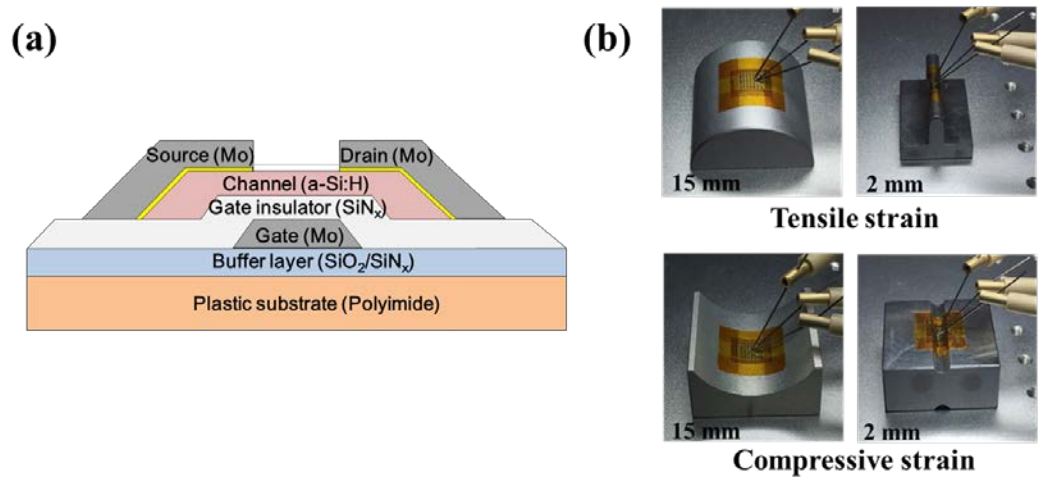

Figure 1: (a) Schematic diagram of a bendable a-Si:H TFT and (b) optical images of homemade bending stages.

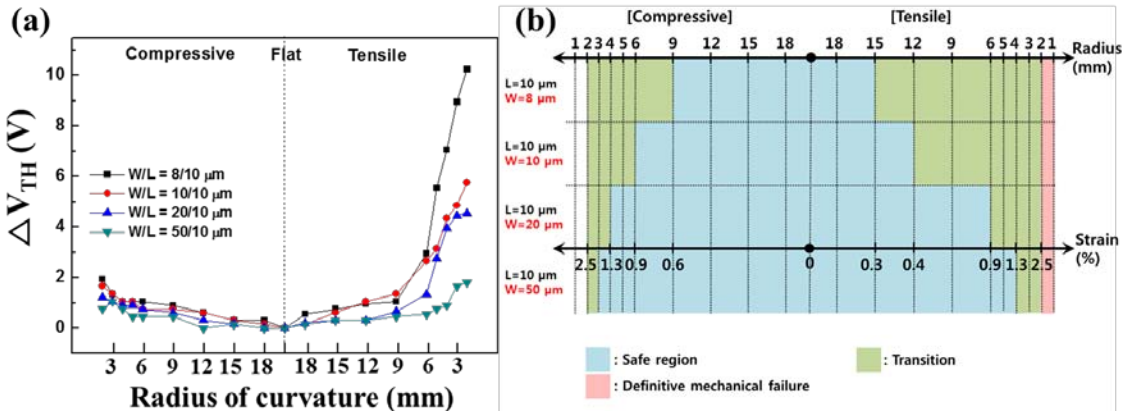

Figure 2: (a) The threshold voltage shift as a function of radius curvature and (b) operation regions of a-Si:H TFTs as a function of bending radius and mechanical strain.