**A Novel TFT-Driven Microchannel Electrophoresis Device for Protein Separation and Identification**

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The amorphous silicon (*a*-Si:H) thin film transistor (TFT) has been applied to many microelectronic devices.[1,2] Because of many advantages of its fabrication, the *a*-Si:H TFT can extend new applications, such as bio-medical and bio-analytical sensors. The authors recently reported a new type of microchannel device that separated and detected protein in one step.[4,5] However, the system was not stabilized in the initial operation stage, e.g., current fluctuates drastically. Since the *a*-Si:H TFT has a stable operation current, it can be connected to the microchannel electrophoresis device to serve as an electrical current regulator. In this paper, we investigate the feasibility of applying the a-Si:H TFT to stabilize the operation current of the microchannel electrophoresis device to enhance its function in separating and identifying proteins.

Figure 1 shows a basic description of the *a*-Si:H TFT connected to the microchannel device. For TFT fabrication, a conventional inverted, staggered tri-layer *a*-Si:H TFT structure was used. The Mo gate was dc-sputter deposited on the Corning 7059 glass. The gate electrode was patterned with the first mask and was etched with an acid solution. The $SiN_x$/*a*-Si/$SiN_x$ tri-layer was deposited with PECVD at 250ºC. The top channel stop $SiN_x$ layer was then defined by the backlight exposure using the gate electrode as the self-aligned mask.[1,2] An $n^+$ *a*-Si:H layer was deposited to form the ohmic contact. The Cr layer was sputter deposited, defined with the second mask, and subsequently etched with an acid solution. Finally, the $n^+$ layer was etched with RIE. The complete TFT was thermally annealed at 250°C to remove plasma damages.

To form the microchannel and reservoir structures, a thick layer (30μm) of negative photoresist (SU-8, Microchem Co.) was spin-coated and patterned with the third mask. After covering the opening channel region with a cellulose tape, the channel was filled with a 15% poly acrylamide gel (in a 0.5× TBE solution). The electrophoresis experiment was done with an electrical field of 10 V/cm. A mixture of three kinds of proteins, *i.e.*, ovalbumin (45 kDa), carbonic anhydrase (29 kDa), and α-lactalbumin (14.2 kDa), were used in the experiment. The electrical current (I) change with time (t) was monitored with an Agilent 4155C analyzer.

There are many possible causes for electrical perturbation of the current, such as the system instability by an electrical field or the solution evaporation due to the sudden rise of temperature, etc.[3,4] Figure 2 shows that the incorporation of a TFT improves the performance of the electrophoresis device by removing the severe initial current perturbation. The three proteins are clearly identified with the improved device.

In summary, the authors reported a new type of TFT driven microchannel for protein separation and identification. The introduction of the TFT to microchannel electrophoresis made the system more stable and reliable.

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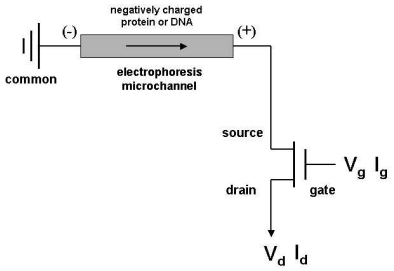


Fig. 1. Schematic View of a Microchannel System connected to an *a*-Si:H TFT

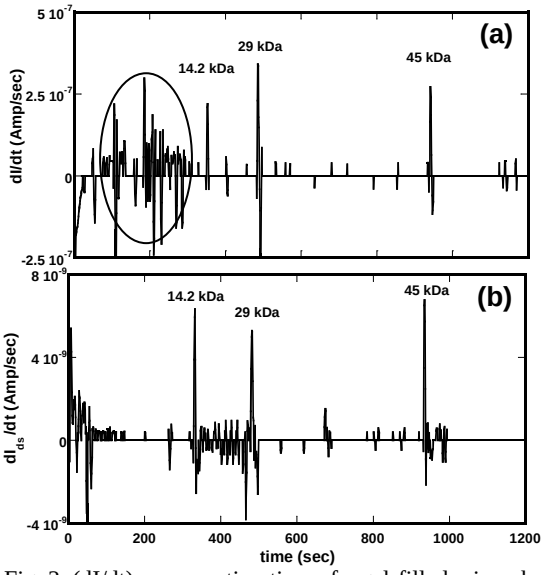


Fig. 2. (dI/dt) vs. operation time of a gel-filled microchannel electrophoresis device (a) without and (b) with an a-Si:H TFT connected.