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Monolithically Integrated Stretchable TFT Array with Liquid Metal Interconnects

Although many approaches have been successful in realizing stretchable electronic circuits, it is still required to find out more practical manufacturing schemes that are highly compatible with the conventional technology. In the present work, we provide a stretchable circuit with an array of oxide thin film transistors (TFTs), where TFTs are located within rigid polyimide islands and connected by eutectic gallium-indium (EGaIn) liquid metal interconnects. By a new "roll-painting and lift-off" technique based on the conventional photolithography, we can produce liquid metal interconnects precisely aligned to preformed TFTs, and obtain monolithically integrated circuits with the hybrid configuration. For constructing stretchable circuits, we first produced oxide TFTs and crossing units of two metal layers within polyimide islands patterned on a Si substrate, and then formed the EGaIn interconnects for connecting those elements, and finally transferred the whole circuit layer to a stretchable polydimethylsiloxane (PDMS) substrate. With this hybrid structure, when the substrate is stretched, only liquid metal interconnects within the PDMS region are elongated accordingly, while solid TFTs within the stiff polyimide region undergo little deformation maintaining stable operations. This scheme is highly compatible with the current flexible circuit technology, as the liquid interconnects are formed additionally after all other components (including polyimide islands, TFTs, and crossing units) are fabricated on a rigid substrate by conventional processes. For a 4 x 4 array of TFTs within a 20 mm x 20mm area, we demonstrate that the characteristics of each addressed TFT remain nearly constant up to 40% tensile strain.

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