5.4 Self-healing printed thin film transistor circuits

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Thin film transistors (TFTs) are the building blocks of large area electronic systems. Amongst the several methods to manufacture TFTs, additive ink jet printing offers on demand, bespoke integrated circuits on rigid and flexible substrates. However, inkjet printed electronics are subject to reliability related problems in devices and interconnects. Interconnects of thin film circuits on flexible substrates experience open circuit failures due to mechanical and thermal stress, electrostatic discharge and chemical corrosion.

There have been several approaches to improve the reliability of interconnects. The first is the development of novel materials enabling stretchable conductive materials. The second is the development of novel geometries and fabrication processes permitting meandered and helical interconnects. The third is the development of self-healing interconnects permitting the real time repair of interconnects.

Self healing interconnects have been demonstrated using liquid metals, micro-encapsulated conductive ink that spill upon mechanical fracture of the shell and electric field assisted self-healing (eFASH) using dispersions of conductive particles in insulating fluids [1] (Fig. 1). In eFASH, a dispersion of conductive particles in an insulating fluid is contained over a current carrying interconnect. Upon the occurrence of an open circuit fault field appearing in the open gap polarizes the particles in the dispersion resulting in them chaining up due to dipole-dipole interaction. These chains form bridges across the gap and heal the fault.

Here we demonstrate the self-healing of open circuit faults in ink-jet printed TFT circuits on flexible substrates using eFASH. Successful healing on TFT circuits show complete restoration of dc and ac characteristics. The noise performance of the heal is also analysed and is shown to be within acceptable limits. Most importantly, the heals are shown to permit bending and flexing showing strains of 12 to 60 depending on the strain rate. The ability of eFASH to address interconnect failures during circuit operation in real time promises highly reliable printed TFT circuits.

References


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