Thinfilm Printed Ferro-Electric Memories and Integrated products

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***Abstract*—Printed electronics has recently moved from a focus on the production of individual components towards the design and initial commercialization of integrated systems. This paper describes the current status and further trends of ferroelectric nonvolatile memories as developed and produced by Thin Film Electronics.**

Keywords— Printed memory, ferroelectric, printed transistors, integrated products

Printed electronics has recently moved from a focus on the production of individual components towards the design and initial commercialization of integrated systems. In order to create such systems, the use of non-volatile random access memory is often essential. This presentation describes the function and design of Thinfilm memories, based on a reversible ferro-electric capacitor structure, and their application to novel products and markets.

A Thinfilm memory cell consists of a ferroelectric polymer sandwiched between two electrodes, denoted arbitrarily as a bit line (BL) and a word line (WL). On the application of a sufficient voltage, the dielectric dipoles within the polymer layer align, and because of hysteresis when the voltage is removed, the dipoles remain pinned in the state they had during the voltage pulse.

Although driving a single cell is more or less trivial, driving a full array of memory cells is somewhat more complex. Thinfilms array memories rely on a passive array structure, which consists of two sets of perpendicular electrodes with the ferroelectric film sandwiched between them. The main challenge with the passive array architecture is that unaddressed cells will experience disturb fields during write operations. However, with the choice of proper materials, their processing and the proper drive protocol during read and write, the disturb fields can be held to acceptable levels.

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The Thinfilm memories are being produced with various print processes. At one of our partners, Inktec ltd in South Korea, the silver electrodes are printed using direct gravure, the polymer memory film is coated using slot die while the protection layers and the carbon pads are printed using rotary screen printing. The carbon contact pads are used to connect the memory cells to external read and write circuitry.

Increasing the storage capacity further of "memory only" components requires the increase of the number of contact pads. That can be acceptable for some applications but not for others. In fact, for some applications there is a drive to lowering the number of contact pads. That can be achieved by integration with transistors. From a cost point of view, the transistors should preferably be printable. Memory devices of this kind (printed addressable memory) have been demonstrated by Thinfilm and PARC.

Although memory is an essential part of all electronics, adding printed sensors, batteries and displays opens the door to a range of new products and applications. Examples include low cost sensor tags, disposable price displays and RFID tags. Each of these "system products" requires process integration or assembly of different technologies and is thus technically more complex than the memory stand-alone product. Several demonstrators of system products have been built by Thinfilm and partners and will be described.

One of the demonstrators is a proof-of-concept prototype of an integrated printed electronic tag based on rewritable memory. The printed electronic label, consisting of printed memory, sensor and logic, detects that critical temperature thresholds have been exceeded and records data digitally for later retrieval and display. The tag comprised of four different printed technologies. However, external power was used for that demonstrator. Recently, a standalone tag was demonstrated. It is an integrated printed electronic system powered solely by batteries. In the system demonstrated, organic logic detects that a critical temperature threshold has been exceeded and signals the display driver to turn on an electro-chromic display.