All Inkjet Printed Plastic RFID Tag

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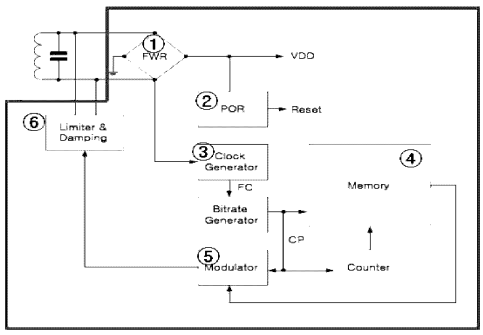
Introduction

In recent years, as the demand for ubiquitous electronics is largely consumer driven, in some field factors such as disposability, low cost and massive market applications are becoming more important than ultrapowerful microelectronic devices.[1] Therefore, macroelectronic devices that are light, inexpensive, flexible, disposable, and minimally sufficient to execute the simple task at hand are in high demand. Inexpensive radio frequency identification (RFID) tags, flexible displays, disposable cell phones and e-papers are among the potential applications. To make practical use of these applications, their components should be prepared using simple and inexpensive means such as printing technologies that do not require using high vacuum deposition or photolithography facilities.[1] Therefore, their active materials such as plastics and small molecules may be preferred over silicon or metals. We describe here a method en route to print RFID tag with transistors or without transistors.

The RFID tags with (Fig 1) and without thin film transistors (TFT) (Fig 2) presented here are manufactured using all printing process on 30 μm thick polyimide films.



[Block diagram of the designed transponder IC(Tag)]

Figure 1. Schematic structure of all printed RFID tag .

Figure 2. 1 Bit RF tag with sizes of 7 x 7, 5 x 5, and 4 x 4 cm^2

Experimental

High resolution inkjet printer has been used to fabricate RFID tag with and without TFT. To print antenna, electrodes and wires, silver-polypyrrole nanocomposite ink with conductivity of 2 x 10^5 S/cm has been employed. Furthermore, semiconducting SWNT inks has been used for printing active layers of TFT, and insulating ink formulated with polyimide has been used for printing gate dielectric layers.

Results and discussion

The RFID tags with and without TFT are manufactured using all inkjet printing method without using any photolithographic technology on a 30 μm thick polyimide film.

For RFID tag with TFT, the p-type semiconductor used in our system is semiconducting SWNT, printed from SWNT inks with channel length of 40 μm. TFT consistently provides field-effect mobilities in the saturation region of 230 cm^2/Vs and on/off current ratios of 10^2 (Fig. 3). A crucial element in any DC-powered tag (Fig. 1) is the rectifier, the only device that must properly operate at the RF carrier frequency. In our system, the full wave rectifier has been adopted.

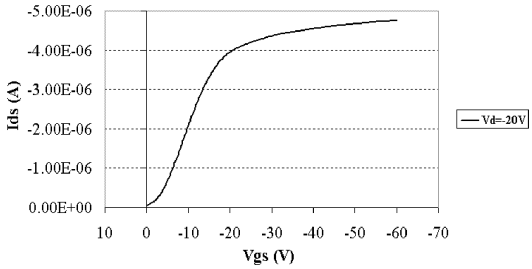


Figure 3. Transfer characteristic of SWNT TFT used for constructing plastic RFID tag.

For manufacturing RFID tag without TFT (Fig. 2), we employed the concept of LC resonant circuits adjusted to the defined frequency f_R. For 1 bit-transponder, the frequency of 8.2 MHz is tuned because it will be useful in the system of electronic article surveillance (EAS) (Fig. 4). For 2 bit- transponder, the frequencies of 6 MHz and 28 MHz are chosen to avoid possible collision during the reading (Fig. 5).

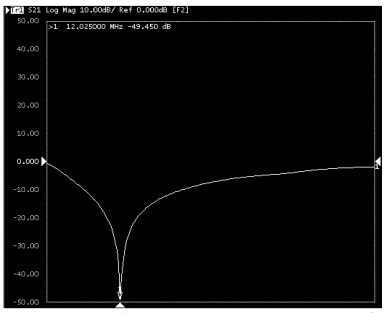


Figure 4. 1 Bit-transponder characteristic for printed RF tag.

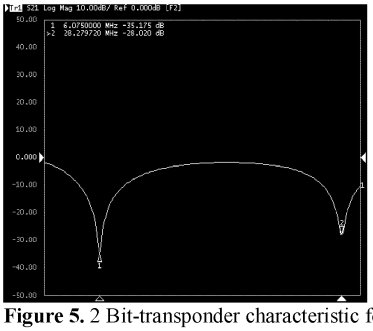


Figure 5. 2 Bit-transponder characteristic for printed RF tag.

Conclusions

In summary, a complete 1 and 2 bit RFID tag systems without TFT using all inkjet printing method has been successfully presented working in the range of 6 to 28 MHz, which is possibly used in the field of EAS. Also reported are the ways of printing plastic RFID tag with TFT using SWNT TFT.

References

[1] Forrest, S. R. *Science* **2004,** *428*, 911.

Acknowledgements

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