



ITC 2012



8th International Thin-Film Transistor Conference – Book of Abstracts

Calouste Gulbenkian Foundation
30-31 January, 2012
Lisbon, Portugal

FCt **i3N**
FACULDADE DE
CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

SPICE model for lossy piezoelectric PVDF-TrFE touch sensor integrated with flexible polysilicon TFTs

F. Maita¹, L. Maiolo^{1,2}, A. Pecora¹, A. Valletta¹, D. Ricci², G. Metta² and G. Fortunato¹

¹IMM-CNR, Via del Fosso del Cavaliere 100, 00133 - Roma (Italy),

²RBCS, Italian Institute of Technology, Via Morego 30, 16163 - Genova (Italy)

E-mail: francesco.maita@artov.imm.cnr.it

Touch sensing, in robotics, is defined as the continuous sensing of variable contact forces [1]. Today, touch sensing technology has improved and many new touch sensors have been presented [2]. These kinds of devices, can exploit piezoelectric polymers such as PVDF and other copolymers that can transduce the contact forces into charge modulations. We propose to integrate these sensors with low temperature polysilicon thin film transistors (LTPS TFTs) fabricated on flexible substrates, adopting an extended gate configuration. Such a device can respond to an external mechanical stimulus with a shift in current/voltage TFT characteristics. To better understand the sensor behavior, we present a transmission line equivalent model for lossy piezoelectric PVDF-TrFE and its SPICE implementation. The model includes the mechanical/viscoelastic, dielectric/electrical, and piezoelectric/electromechanical losses by using complex elastic, dielectric, and piezoelectric constants obtained from the measured impedances of PVDF-TrFE samples. The model assumes that an acoustic wave generated by a force applied onto PVDF capacitor travels across the material just as an electrical wave across a lossy transmission line [3]. Piezo-electrical conversion is then implemented by the use of controlled-sources in the Laplace domain and lossy capacitor is added to schematic in order to consider dielectric losses of the polymer. The simulation of TFT dynamic parameters was carried out using Level 62 RPI Poly-Si TFT Model in the Hspice simulation workspace and was based on parameters extracted from the experimental data. The electrical parameters of the LTPS TFTs fabricated on polyimide [4] and employing a double channel architecture to reduce the kink-effect are: $\mu_{fe} \sim 40 \text{ cm}^2/\text{Vs}$; $V_T \sim 6\text{V}$ and a transconductance $g_{m-SAT} = 0.1 \div 0.5 \text{ mS}$ for devices with $W=400 \text{ }\mu\text{m}$ and $L=10 \text{ }\mu\text{m}$. Simulations allowed to optimize both sensing PVDF-TrFE capacitor and LTPS TFT geometrical parameters.

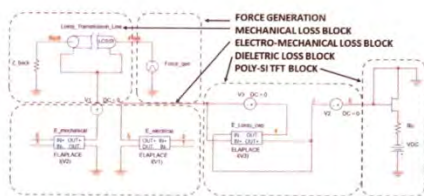


Fig. 1. POSFET model in SPICE workspace

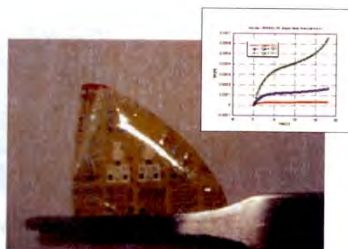


Fig. 2. A photograph of the device with its output characteristic

References

- [1] K.E. Pennywitt, Robotic tactile sensing, Byte 11 (1) 177–200 (1986).
- [2] R.S. Dahiya, G. Metta, M. Valle, A. Adami and L. Lorenzelli, Appl. Phys. Lett. 95, 034105 (2009).
- [3] R.S. Dahiya, M. Valle and L. Lorenzelli, IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 56, no. 2, (2009)
- [4] A. Pecora, L. Maiolo, M. Cuscunà, D. Simeone, A. Minotti, L. Mariucci, G. Fortunato, Solid State Electron. 52, 348–352 (2008).