Direct-written and Low-voltage Polymer Field-Effect Transistors Operating at Radio-Frequencies

Mario Caironi[1]

Center for Nano Science and Technology @PoliMi[1]
Istituto Italiano di Tecnologia
Milano, 20133 Italy

E-mail: mario.caironi@iit.it

Printed polymer field-effect transistors (FETs) have been considered for many novel applications towards large area and flexible electronics, since they can enable pervasive integration of electronic functionalities in all sorts of appliances, their portability and wearability. However, printed polymer FETs fabricated with scalable tools fail to achieve the minimum speed required for example to drive high-resolution displays or to read the signal from a real-time imager, where a transition frequency (f_T), i.e. the highest device operative frequency, above 10 MHz is required. Such goal is even more critical to achieve with low operating voltages and on cheap plastic foils. Here, we demonstrate that high-frequency, low-voltage, polymer field-effect transistors can be fabricated on plastic with the sole use of a combination of scalable printing and digital laser-based techniques. These devices achieve f_T in the MHz range already at 2 V, and reaches a record 14 MHz f_T at 7 V [1]. These devices can be successfully integrated into a rectifying circuit on plastic operating at 13.56 MHz, allowing to supply a DC voltage to RF devices and tags fabricated with cost-effective production processes. The progress into radio-frequency operation is supported by S-parameters measurements [2], a standard in high-frequency electronics, yet seldom applied to polymer electronics. Such characterization tool allowed also to assess the progress to even higher f_T values, enabled by recent efforts on the reduction of capacitive parasitism, thus exploring a radio-frequency range never achieved with organic electronics before.

Reference:

[1] Perinot, A.; Caironi, M.; "Accessing MHz Operation at 2 V with Field- Effect Transistors Based on Printed Polymers on Plastic" Advanced Science 2019 6, (4) 1801566
[2] Giorgio, M.; Caironi, M.; "Radio-Frequency Polymer Field-Effect Transistors Characterized by S-Parameters" IEEE Electron Device Letters 2019 40, (6) 953-956.