From micrometric to nanometric scale switching of CuTCNQ-based non-volatile memory structures

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Emerging high density non volatile memory concepts are widely investigated to replace flash memories below the 22 nm technological node. Among the potential alternatives, resistive switching memories (so-called ReRAM) integrating organic complexes attract much attention [1-2]. In these structures, the switching is controlled by external current or voltage. High density, large discrimination between ON (or low resistance state, LRS) and OFF states (or high resistance state, HRS), high endurance, long term retention and low cost are the main criteria required for this new generation of non-volatile memories.

The present study is focused on CuTCNQ metal organic semiconductor exhibiting reversible bipolar switching. The switching behavior between HRS and LRS of Cu/CuTCNQ (300 nm)/Al memory elements was evaluated for Al top electrode diameters from 1000 down to 150 µm. A pulse sequence was applied to the structures to program and check the memory state: after each set and reset occurring below ± 5 V, a current read at V_{read} = - 1 V was done. Electrical testing revealed discrimination between high and low resistance states depending on the top electrode area.

Besides, Conductive-AFM experiments were performed to investigate switching at nanometric scale. The PtIr coated tip biased at - 9 V (set) and 9 V (reset) (with grounded Cu bottom electrode) was scanned over an area of 0.1 × 1 µm on CuTCNQ surface to induce local switching. The local current response was subsequently measured at - 1 V after each set/reset operation demonstrating inhomogeneous set since only few switched areas are observed. Complete I(V) characteristics were measured by contacting CuTCNQ film with tip and sweeping the voltage between - 8 and + 8 V. A local, reversible and bipolar switching of CuTCNQ film is clearly observed right under the tip apex with voltage set and reset around ± 5 V.

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[2] T. .Kever *et al.*, *Appl. Phys. Lett*, vol. 91, p. 083506, 2007

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