A write-once organic memory made from dendrimer multilayers

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Introduction

• Electrical switching has been observed in polymers, LB films, and small $\pi$-conjugated organic molecules.

• As a potential candidate for organic electronic or optical devices, some optical- or electrochemical-switchable dendrimers have been reported. However, there is still no reports on the electrical-switchable dendrimer devices.

• Here, we want to present our observations on the electrical switching and memory properties of redox dendrimer multilayer devices.
Schematic sandwich device structure (a) plant view and (b) cross section view.
Molecular structures of the organic materials used.

4AAPD

TPD
Typical I-V characteristics of an 4AAPD and TPD sandwich device just before and after switching.
The stability of the 4AAPD and TPD sandwich devices after switching in ambient conditions.*

*Note: All the resistance were calculated from the slope of the corresponding I-V curves.
Thickness dependence of the switching threshold voltages for the Ag/TPD/4AAPD/TPD/Ag devices (the top and bottom TPD layers are the same thick).
Electrical switching could also be observed in TPD and 4AAPD multilayer devices. After switching, the multilayer devices kept stable in the high conductive state under different applied voltages.
No similar switching phenomena could be observed from TPD or 4AAPD single layer devices even scan to breakdown voltage.

Also no switching observed in TPD and 4AAPD bilayer devices. The electrical switching and memory properties were thus attributed to both the special sandwich energy level structure and the unique redox-switchable 4AAPD embedded layer.
Schematic energy level diagram of the 4AAPD and TPD sandwich device.

Possible switching mechanism: When a threshold external electrical voltage was applied to the TPD and 4AAPD multilayer devices, charges would be trapped in the embedded 4AAPD layer. The trapped charges may further induce the oxidation of the redox-switchable 4AAPD materials and thus lead to the observed electrical switching and memory phenomena.
Conclusions

• Electrical switching and memory behavior were observed in 4AAPD and TPD multilayer devices.

• The conductive state kept stable in ambient conditions. The conductivity difference is about three orders of magnitude before and after switching.

• It was shown that both the special energy level structure and the unique redox-switchable 4AAPD embedded layer play a key role in the switching and memory performances.