Non-volatile Polymer Memories for Flexible Electronics

Silicon is the paradigm of semiconductors. However, other materials, mostly known as insulating, can indeed show properties similar to those of silicon. These carbon–based (organic) materials are at the heart of the modern field of organic electronics. This project addresses a specific type of non-volatile ferroelectric organic memories, aiming to clarify the morphology of the active layer.

**GENERAL MOTIVATION AND OBJECTIVES**

The aim of this project is to unravel the operating mechanism and the role of phase separation details of non-volatile resistive polymer memories making use of ferroelectric polymers blended with semiconducting polymers, with a view to the improvement of performance and minimization of their dimensions. This proposal aims to contribute to the development of these device by:

1. addressing the study of the phase separation, using cross-linkable semiconducting polymers to get a direct imaging of the phase separation domains;
2. taking advantage of the luminescence properties of the semiconducting polymers, to obtain a deeper insight into the effects of the ferroelectric ordering on the semiconducting polymer photo-physical properties in the bulk of the active layer;
3. finding the ferroelectric domains upon solvent evaporation. The aim of the project was to image directly the morphology of the active layer to establish the domains organization. To achieve that, we relied on the use of a cross-linkable conjugated polymer (F8T2Ox1), that is, a polymer that is turned into an insoluble form (r-F8T2Ox1) upon formation of chemical bonds between different chains forming a network. This way, upon cross-linking of the semiconducting polymer after the blend film is formed, we could selectively remove the ferroelectric polymer upon washing with a proper solvent, leaving the semiconducting polymer behind. The remaining film was then characterized by Atomic Force Microscopy and X-Ray photoelectron spectroscopy (XPS).

We found that the ferroelectric polymer accumulates mostly at the upper surface while allowing the continuous paths of semiconductor polymer (Figure 2), roughly supported the assumed morphology. However, we also found that there is an incomplete separation at the domains boundary with some ferroelectric polymer being trapped in a diffuse interface. The existence of this diffuse interface is not taken into account in the proposed operation model which, we believe, calls for its modification. In addition, we also find that the formation of the ferroelectric domains affects the photophysical properties of the conjugated polymer which we attribute to the local electric fields that are formed. In particular, we find that the luminescence of the semiconducting polymer is quenched when in presence of such domains.

**Fig. 1** Scheme of a non-volatile ferroelectric organic memory and internal morphology.

**Fig. 2** ON/OFF ratio for a AMVDF-TrFE/F8T2/OE-Lx device over various programming cycles as a function of the pulse voltage.

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**PROJECT WEBPAGE URL**
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