

Type of presentation: Poster

IT-10-P-2565 Using transmission electron tomography to unravel the structure of hybrid active layers in non volatile memory elements

Girleanu M.^{1,2}, Nau S.³, Sax S.³, List-Kratochvil E.^{3,4}, Soliwoda K.⁵, Celichowski G.⁵, Grobelny J.⁵, Brinkmann M.¹, Ersen O.²

¹Institut Charles Sadron, UPR-22 CNRS, 23 rue du Loess, BP 84047, 67034 Strasbourg cedex 2, France, ²Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504 CNRS-UdS, 23 rue du Loess BP43, 67034 Strasbourg cedex 2, France, ³NanoTecCenter Weiz Forschungsgesellschaft mbH, Franz-Pichler-Straße 32, A-8160 Weiz, Austria, ⁴Institute of Solid State Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria, ⁵Department of Materials Technology and Chemistry, Faculty of Chemistry, University of Lodz, Pomorska 163, 90-236 Lodz, Poland

Email of the presenting author: girleanu@ipcms.unistra.fr

The interest in plastic electronics has grown significantly over the last twenty years with the development of new electronic devices, particularly solar cells and field effect transistors. More recently, non-volatile memories (NVMEM) based on hybrid materials gained particular interest [1,2]. Typically such devices consist of an insulating or semi-conducting layer sandwiched between a bottom ITO electrode and an upper metallic electrode (silver or aluminum). Bias application on these devices switches them from a low current OFF state to an ON state at high current. The switching mechanism involves the formation of "conducting filaments" [3] in the active layer but no direct observation of such filaments in a hybrid device was demonstrated so far. In hybrid layers, the formation of filaments is eased by the presence of metallic nanoparticles. It is therefore important to understand how such nanoparticles are dispersed in a polymeric matrix. In this study, we have analyzed the morphology of hybrid layers of polystyrene loaded with functionalized Au nanoparticles (NPs). TEM tomography allows to determine the 3D distribution of the nanoparticles in the devices. Evidence is found for the formation of large clusters of Au NPs that are rejected to the top surface of the active layer during the film spin-coating. Moreover, a fraction of Au NPs is dispersed in the PS film but only within an interfacial layer close to the bottom ITO substrate whereas the largest part of the PS matrix does not contain any Au NPs. It is shown that TEM tomography is a valuable tool to unravel the 3D structure of the active layers in NVMEM.

[1] J.C. Scott et al., Adv. Mater. 2007, 19, 1452.

[2] B. Cho et al., Adv. Funct. Mater. 2011, 21, 2806.

[3] S. Nau et al., Adv. Mater. 2014, DOI: 10.1002/adma.201305369.

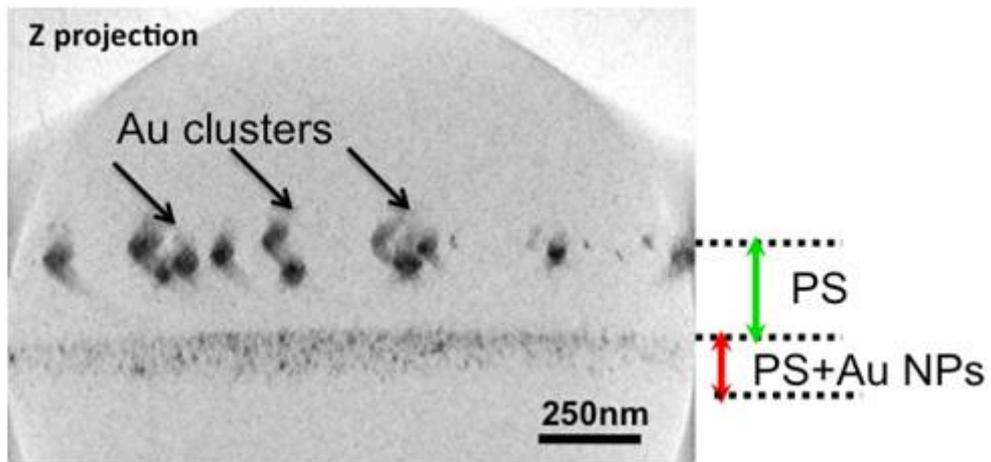


Fig. 1: Cross-sectional view of the active layer of a hybrid non volatile memory element obtained by tomography. The active layer is made of a polystyrene matrix loaded with Au nanoparticles.