Optimization of physical chemistry of the Pt/Ru/Pb(Zr,Ti)O_3 (PZT) interface for future high capacitance density devices

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The growing need for the integration of an increasing number of functions into the new generation of portable devices contributes to overcrowding of printed circuit boards. In this context, the miniaturization of discrete components is imperative to maintain a manageable size of the printed circuit boards. The capacitors, present in our cell phones today, occupy more than 50% area of all discrete components. There is thus a strong interest in going towards the densification and the integration of those components. The success of such integration relies on the use of both high dielectric permittivity materials and a suitable stacking architecture. Lead Tirconate Titanate (PZT) in decoupling multiple metal-insulator-metal (multi-MIM) stacks is a good candidate for the new generation of integrated capacitors. However, capacitor performance is heavily affected both by the PZT compositions and the quality of the interface with the electrodes. Therefore, it is important to engineer surface (PZT) and interface (Pt/Ru/PZT) physical chemistry which does not degrade the multi-MIM performance. This research has provided valuable information on the correlation of PZT surfaces properties and electrical responses from Pt/Ru/PZT(220nm)/Pt presented in **Fig. 1**. *Operando* HAXPES methodology showed in **Fig. 2**, made it possible to investigate Lead (Pb) excess precursors in PZT sol-gel solution and Post Metallization Annealing (PMA) impact on the electrical functioning of Pt/Ru/PZT/Pt stacks. This work is a new step towards a complete understanding on the behaviour of the interface between electrodes and the PZT ferroelectric, in device-like multi-MIM or 3D-MIM heterostructures, in terms of electronic properties, capacitance density, loss tangent and breakdown field (Reliability).

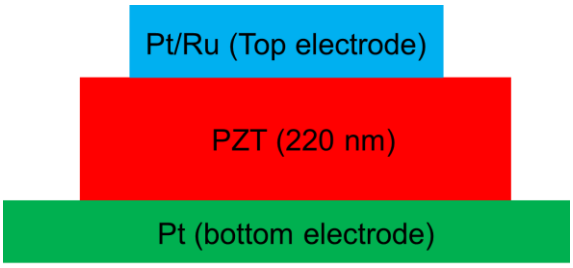


Fig. 1 : Pt/Ru/PZT(220nm)/Pt capacitor

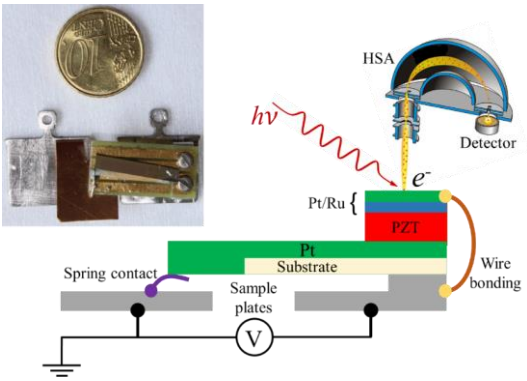


Fig. 2 : Operando HAXPES set-up

Keywords: Electrical properties, HAXPES, PZT, XPS

Professional Biography

Ibrahima Gueye has completed his PhD at the age of 30 years from Grenoble-Alpes University and CEA-LETI at Grenoble. He specializes in the study of solid materials, surfaces science and thin films based on perovskite structures. He has published more than 5 papers in reputed journal.

Recent Publications

- Correlation of electrical characteristics with interface chemistry and structure in Pt/Ru/$PbZr_{0.52}Ti_{0.48}O_3$/Pt capacitors after post metallization annealing, **I. Gueye**, G. Le Rhun, O. Renault, D. Cooper, E. Defay, N. Barrett. ***Appl. Phys. Lett.*** **- Under review**
- In-situ X-ray diffraction on functional films using a laboratory source during electrical biasing, B. Allouche, **I. Gueye**, G. Le Rhun, P. Gergaud and N. Vaxelaire, **Accepted in Materials & Design (DOI: 10.1016/j.matdes.2018.05.016)**
- Electrical response of Pt/Ru/$PbZr_{0.52}Ti_{0.48}O_3$/Pt capacitor as function of lead precursor excess, **Ibrahima Gueye**, Gwenael Le Rhun, Olivier Renault, Emmanuel Defay, and Nicholas Barrett, ***Appl. Phys. Lett.*** 111,222902 (2017)
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