Scaling potential of local redox-processes in memristive $SrTiO_3$ thin film devices

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A large variety of binary and ternary oxides exhibit resistive switching phenomena, or so called memristive behavior [1]. In the search for promising oxide materials for future non-volatile memories, special attention has to be paid to their scaling capabilities. The issue of scaling is strongly linked to the question of, whether the switching current is distributed homogeneously across the device area or localized to one or a few conducting filaments. In this work, we addressed the question where resistive switching takes places in single crystalline Fe-doped $SrTiO_3$ thin films and memristive devices. We compared resistive switching induced by the tip of the AFM, acting as virtual electrode on the bare thin film surface, with the switching properties observed in memristive devices with Pt top electrode. In order close the gap between these two approaches, we combined conductive AFM with a delamination technique to remove the top electrode of Fe-doped $SrTiO_3$ MIM structures to gain insights into the active switching interface with nanoscale lateral resolution. This enabled us to prove the coexistence of a filamentary and an area-dependent switching process with opposite switching polarities in the same sample (Figure 1)[2]. The spatially resolved analysis by transmission electron microscopy and photelectron spectromicroscopy gave us some hints that the two switching types take place in device areas with different defect density and significant stoichiometry.

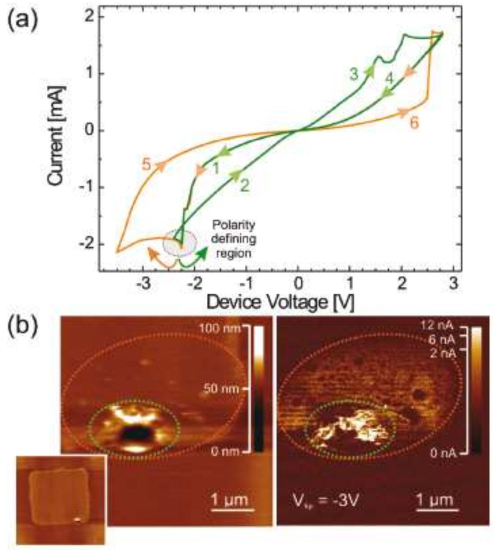

Fig.1 a) *I–V* - characteristic of a Fe-doped $SrTiO_3$ thin film. (b) Conductive AFM topography and current image of a junction after electroforming and top electrode removal. [2]

References

1. R. Waser, R. Dittmann, G. Staikov, K. Szot, Advanced Materials 21, 1-32 (2009)
2. R. Münstermann, T. Menke, R. Dittmann, R. Waser, Adv. Mat. **22**, 4819 (2010)