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Topic for a Master Thesis

„ Electron Beam Absorbed Current Imaging on Resistive Random Access Memory “

Introduction: Objective of this project is to perform electron beam absorbed current (EBAC) imaging on TiO_2 based resistive random access memory (RRAM) devices at nanometer scale. RRAMs based on metal oxides features very fast nanoseconds[1] range on/off switching times over an area less than 10x10 nm^2. These devices demonstrate excellent reliability and endurance with over 100K switching cycles[2], thus making them a suitable material for future generations of non-volatile memory storage. Principle of RRAM is based on changing the resistance of nano device between low resistance state and high resistance state by applying an external voltage bias. The external voltage bias creates a stress which leads to dielectric breakdown of insulator layer hence changes its resistance. RRAM based on metal oxide present high quality non-volatile memory and are potential candidate for future memory devices.

THESIS DETAILS:

There are some known metal oxide materials suitable for resistive switching which are HfO2, TiO2, ZnO, CuOx, WO3 and Ta2O5. Among these TiO2 is one of the most preferred material due to its low cost and better understood operation mechanism[3]. RRAM devices to be investigated in this work are fabricated at RWTH and FZJ. The aim is to find the defective area, i.e. the filament formation in TiO2 imbedded in several layers as shown in Figure 1. Applying EBIC technique would then provide new insights about the device structure and operation mechanism.

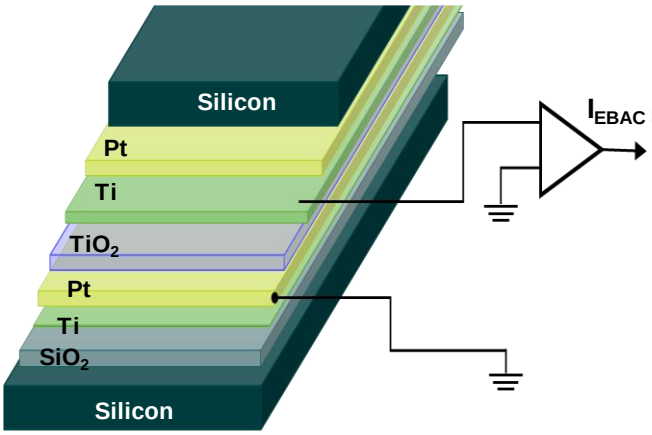

Figure 1: Schematic picture of stack of layers used in this work to investigate properties of filament in TiO_2 layer. Circuit diagram shows

Aim of this project is to utilize EBAC (electron beam absorbed current) to investigate the electrical/resistive properties in RRAM devices.

EBAC technique (also called as resistive contrast imaging) is a quantitative method used to measure electrical properties of semiconductors, metals and insulators at nanometer scale. Electron beam in SEM scans the region of interest by injecting electrons and the current induced at the scanned regions could be collected by EBAC and can be used as resistive imaging. Thus information about local resistance in the material can be obtained. This technique is mostly used for defect localization in metal networks and has been used in previous works for localization of filaments in cells [2] at nanometer scale. Here we use this technique to obtain location of filament in the cell and quantitavely compare the resistive properties by obtaining the results on various metal oxides.

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2. Hayakawa, Y. *et al. 2015 Symposium on VLSI Circuits (VLSI Circuits)* T14–T15 (2015).
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