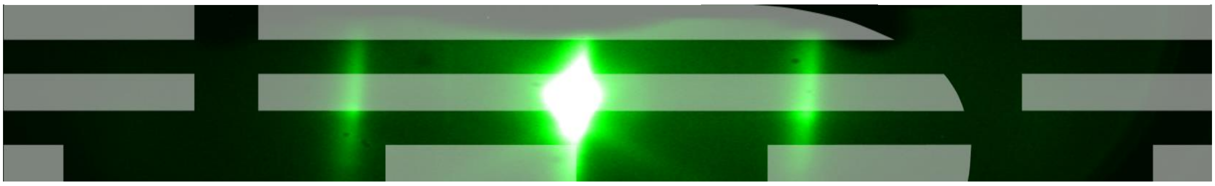
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

IBM Research Zurich



Metallic Oxides

THE BIG PICTURE

Oxide materials have a great technological potential for a broad range of applications, such as novel memory and computing concepts, efficient energy harvesting or sensing. Stimulated 25 years ago by the discovery of high-Tc superconductivity, researchers have invented new techniques to grow high quality thin layers of complex oxides. The underlying motivation was to fundamentally understand the fascinating properties of the oxide thin films, such as, for example, superconductivity, ferroelectricity, electro-optical activity. The use of *single crystal* thin films grown on *exotic and expensive* substrates was initially preferred. However, recent significant progress in deposition tools and methods has enabled the growth of *single crystal* oxide layers onto low-cost large-size *silicon* substrates. The integration of the functional oxides onto Si substrates paves the way to the fabrication of novel devices using standard micro fabrication techniques. This enables new functionalities that we want to exploit in this research project.

DETAILED BACKGROUND

The project will support the ongoing effort to develop and fabricate test structures for the exploitation of two promising oxide properties: 1) piezoelectricity, hence the ability for a crystal to deform under an applied electric field, and 2) resistive switching, hence the ability to change resistance under an applied electric field due to accumulation and depletion of oxygen vacancies and electrons at film interfaces under bias. While piezoelectricity may be used to fabricate a broad range of sensors and actuators, resistive switching may be used for novel neuro-morphic device concepts to compute information logics beyond binary “0” and “1” codes. A key element enabling the fabrication of these test structures is the electrode which needs to be inserted between the active oxide layer and the silicon substrate. The challenge is in finding an electrode which maintains the epitaxial relationship between the silicon and the functional oxide thin film while exhibiting a high enough metallic conductivity. The project will specifically focus on the development of such an electrode.

MASTER PROJECT

The Master student will focus on the investigation of single crystal metallic oxides grown on silicon substrates. Being integrated in a team of experienced researchers, he will be guided and supported in the use of different deposition methods such as sputtering (PVD), molecular beam epitaxy (MBE) or pulsed laser deposition (PLD).
The main task will be to define the best growth methods and conditions for few selected material candidates such as $SrRuO_3$, $LaNiO_3$ and $(La,Sr)CoO_3$ onto $SrTiO_3$ thin films integrated on silicon. Student will be involved in materials characterization as well. In particular x-ray photoelectron spectroscopy and x-ray diffraction will be used to optimize the composition and the crystalline quality of the films. The results of electrical measurements and impedance spectroscopy relative to partial pressure and temperature will be used to assess the materials characteristics and defect chemistry. Based on the outcome their applicability for simple micro-test structure fabrication is evaluated such as for piezos or resistive memories.
The student should be highly motivated, have a strong interest in experimental physics and materials science, and enjoy working in a team.

Project type: Joint master project at IBM Research Zurich&Electrochemical Materials ETH, duration: 6 months

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