Tuning the magnetic and structural properties of Fe_3O_4 films grown on Nb:$SrTiO_3$ substrates

Yifan Xu

1 Abstract

Tuning magnetic oxide phases via redox reactions across their heterointerfaces makes them useful for spintronic and memristive device applications. In Mai Hussein Hamed's previous study, an interesting insight of tuning the Fe_3O_4 thin films on $SrTiO_3$ substrates interface via annealing was given [1]. Inspired by memristor, I further studied to tun it by applying electric field. Using controlled film-substrate interfaces and a small electric field, it is possible that an oxidation/reduction reaction occurs which leads to a reversible phase transition in the thin film.

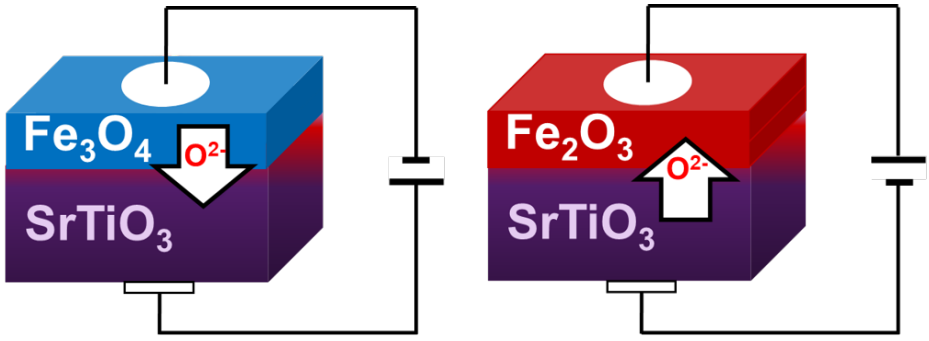

Figure 1: The sketch of Fe_3O_4/TiO_2-terminated Nb: STO with applying negative (left) and positive (right) voltage

The quality of Fe_3O_4 thin films is sensitive to the growth parameters. In my talk, I will first introduce the growth optimization of Fe_3O_4 thin films on Nb-STO using PLD. The characterization of Fe_3O_4 thin films structural and magnetic qualities is introduced in detail. Furthermore, using magnetometry, we can detect the Verwey transition which is a strong indicator of the oxygen content in the Fe_3O_4 films. I will present the observation of a strong change in the Verwey transition with an applied electric field. This can be explained by oxygen diffusion through the interface which leads to a reversible phase transition from Fe_3O_4(magnetite) to γ-Fe_2O_3(maghemite). Additionally, we investigate the structural transitions using ex-situ XRD. In the outlook, I will further propose the possible in-situ measurement while applying voltage in order to study the oxygen stoichiometry, as well as the possible tuning by annealing.

References

[1] Mai Hussein Abdalla Hamed. Interface functionalization of magnetic oxide $Fe_3O_4/SrTiO_3$ heterostructures. Technical report, Elektronische Eigenschaften, 2021.