Ferroelectricity of Er-stabilized beta-MnO_2 film

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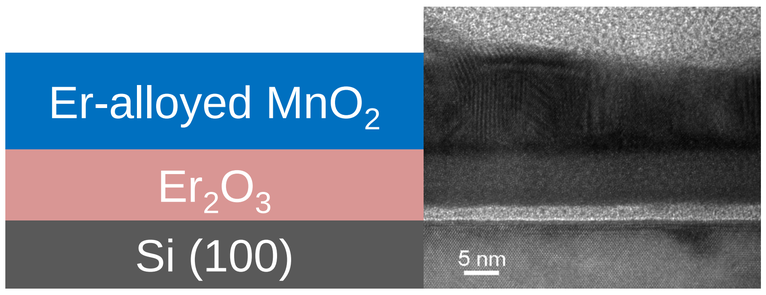
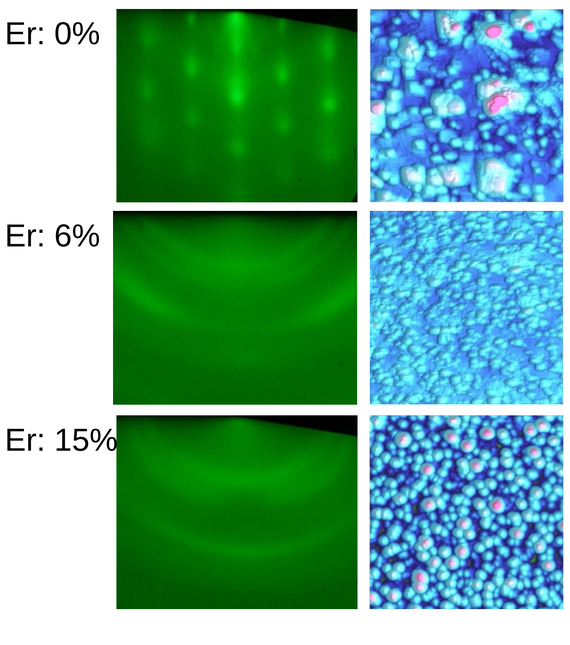
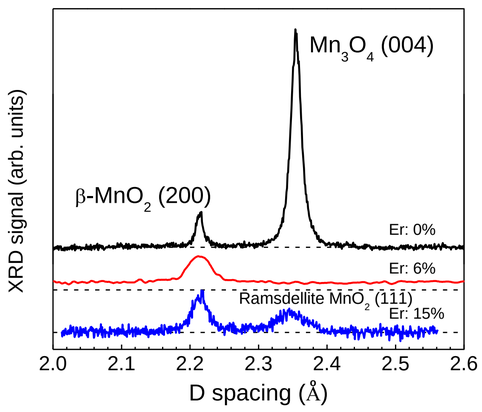
Introduction

Many novel properties, such as high k materials, colossal magnetoresistance, high temperature superconducting, ferroelectrics, ferromagnetics, multiferroics, wide bandgap materials are discovered in oxides. Beta-MnO_2 had been discovered to be ferroelectric 60 years ago, however, few further works have been done. In this work, we grown beta-MnO_2 grain films on Si (100) and observed capacitance hysteresis for the as-deposited and annealed samples, which is assigned to originate from charge trap and ferroelectricity of beta-MnO_2, respectively.

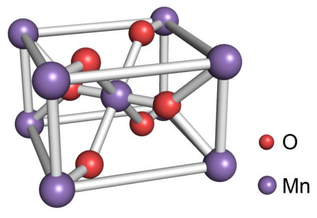


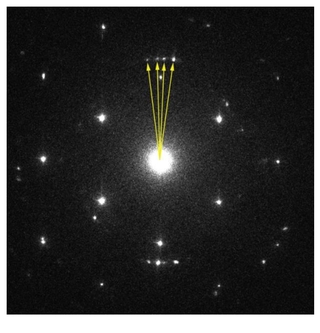
Metal-Ferroelectric-Insulator-Semiconductor (MFIS) structure was grown by molecular beam epitaxy.

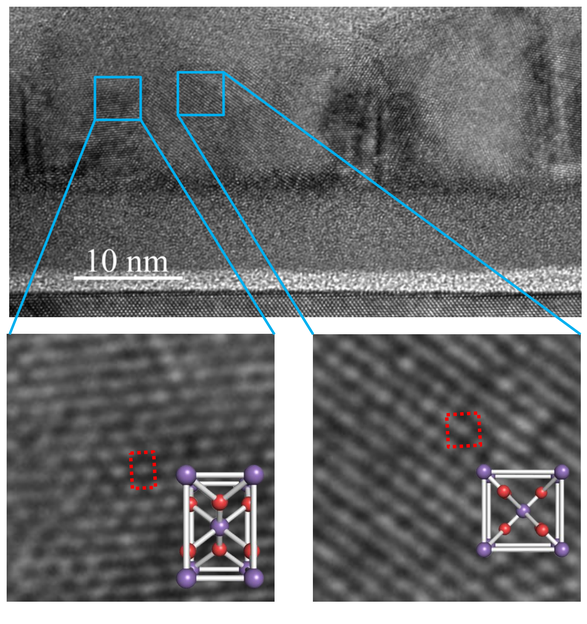




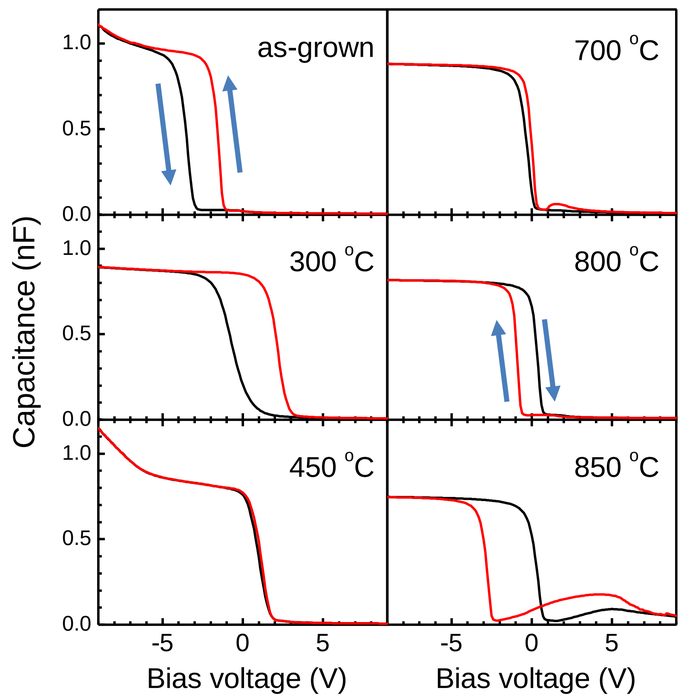
For the pure Mn oxide film, structural transition appears after annealing. By Er-alloying, the structure does not change by annealing at 700°C in vacuum.



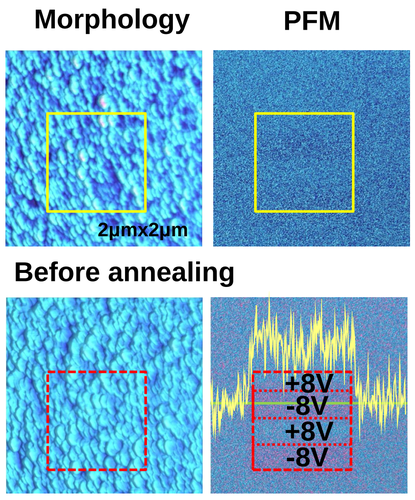




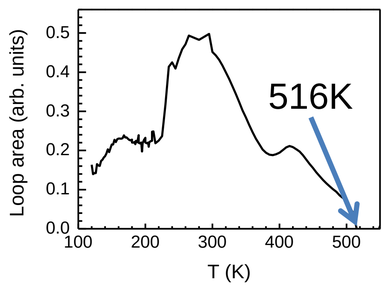
The atomic structure of the Mn oxide film was confirmed to be beta-MnO_2 by XRD and TEM experiments.



Capacitance hysteresis was observed for the as-deposited and annealed samples. The counter-clockwise capacitance hysteresis of as-deposited and low temperature annealed samples was attributed to charge trap of oxygen vacancies. The clockwise capacitance hysteresis of high temperature annealed samples was attribute to the ferroelectricity of beta-MnO_2.



Piezoresponse force microscopy experiment confirms the ferroelectricity of beta-MnO_2.



The Curie temperature was determined to be 516K.

Conclusion

1. Er-stabilized beta-MnO2 films were grown on Si (100).
2. Two kinds of memory mechanisms were observed, i.e. charge trap for the as-deposited films and ferroelectrics for the annealed films.
3. The Curie temperature was determined to be 516K for the ferroelectric transition.