

平成 27 年 6 月 17 日
応用物理学会北海道支部
会員各位

応用物理学会北海道支部講演会のお知らせ

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演題：Defect Engineering in Complex Oxide Thin Films

講師：Woo Seok Choi 氏

(Sungkyunkwan University, Assistant Professor)

日時：平成 27 年 7 月 31 日（水） 14:00～15:00

場所：北海道大学電子科学研究所 1 階セミナー室 1-2

共催：応用物理学会北海道支部（主催：電子科学研究所学術交流委員会）

講演の要旨

Defect engineering in crystals opens new possibilities for discovering novel phenomena and fine-tuning beneficial properties. For perovskite transition metal oxides, however, controlling and understanding the role of the defects have been mainly limited to the oxygen vacancies. In this presentation, we report efficient defect engineering in complex perovskite oxide thin films.

In the first part of my talk, I will report point defect engineering using Pulsed Laser Epitaxy (PLE). In particular, we observed the selective formation of the different types of elemental vacancies and their individual roles in determining the physical properties of perovskite SrTiO_3 homoepitaxial thin films. Among various parameters of PLE, we found that laser energy, oxygen partial pressure ($P(\text{O}_2)$), and oxygen flow rate play distinct roles in influencing both oxygen and cation stoichiometry. In particular, laser energy was mainly responsible for changing the cation stoichiometry, while oxygen flow rate selectively tuned the oxygen vacancy concentration in SrTiO_3 thin films. Moreover, it was found that oxygen vacancy was mainly responsible for the electronic insulator-to-metal transition, but on the contrary to the common belief, did not influence the Sr vacancy induced cubic-to-tetragonal structural transition. The control of multiple phase

transitions in complex oxides exploiting selective vacancy engineering provided by PLE opens an unprecedented opportunity for tailoring and understanding the materials properties.

In the second part, I will discuss the role of epitaxial strain as inducing an ordered defect crystal structure. In particular, we show that the ferromagnetic ordering observed in LaCoO_3 thin films is related to a lattice modulation due to the epitaxial strain, which results in a locally-ordered atomic structure. An unconventional strain relaxation behavior identified by strip-like lattice modulation pattern was responsible for the non-zero spin ground state [1,2]. We note that the unconventional strain relaxation did not involve any uncontrolled misfit dislocations or other defects. Our study provides a novel route to tailoring the atomic structure and magnetic properties of functional oxide heterostructures by strain, for various applications. In particular, the catalytic activity of LaCoO_3 thin films under different strain state has been studied to show the close correlation between the crystal structure and the chemical activity [3].

[1] W. S. Choi et al., Nano Lett. **12**, 4966 (2012).

[2] J.-H. Kwon et al., Chem. Mater. **26**, 2496 (2014).

[3] K. A. Stoerzinger et al., J. Phys. Chem. Lett. **6**, 487 (2015).

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