Manipulating Cation Arrangements and Perpendicular Magnetization Anisotropy in the spinel oxide $NiCo_2O_4$

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$NiCo_2O_4$ (NCO) has the inverse spinel structure and exhibits a wide range of physical properties, such as ferrimagnetism with high Curie temperature, infrared transparency and catalytic activities [1-3]. These important properties often vary with growth conditions, which influence valence states and distributions of cations (Ni and Co). In this study, we grew 30nm-thick NCO epitaxial thin films on $MgAl_2O_4$ (MAO) substrates by pulsed laser deposition and found that while all films display room temperature ferrimagnetism with perpendicular magnetic anisotropy, their magnetic properties strongly depend on growth conditions especially oxygen partial pressure during the growth of films (P_{O2}) .

Figure 1 shows the P_{O2} dependence of room temperature saturated magnetization (M_s), magnetic anisotropy field (H_k) and perpendicular magnetic anisotropy energy (MAE) of the NCO films. H_k was extracted from the in-plane dependence of Hall resistivity at room temperature and MAE was determined by taking $M_s \cdot H_k/2$. All of these parameters are found to increase with increasing P_{O2}, implying that P_{O2} influences cation arrangements in the films. We further carried out resonant x-ray diffraction characterizations of the films and found that decreasing P_{O2} results in lower Ni/Co cation ratio at the octahedral site, which reduces M_s, H_k and MAE. In this presentation, we will also present details of our resonant x-ray diffraction characterizations of the NCO films and discuss how cation arrangements (Ni/Co cation ratio) influence films' magnetic properties including perpendicular magnetic anisotropy.

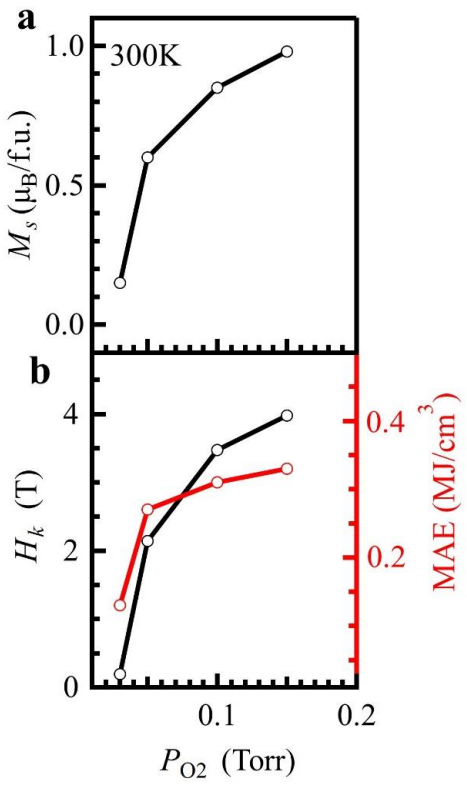

Figure 1. P_{O2} dependence of (a) M_s, (b) H_k and (c) MAE of 30-nm-thick $NiCo_2O_4$ films. All data were taken at 300 K.

[1] P. Li, et al. *ACS Nano 11*, 5011(2017). [2] L. F. Hu, et al. *Adv. Mater 23*, 1988 (2011). [3] D. P. Dubal, et al. *Nano Energy 11*, 377 (2015).