Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Electronic supplementary information

Thickness-dependent magnetotransport properties of rocksalt NdO epitaxial thin films: observation of a ferromagnetic phase far above the Curie temperature

Daichi Saito,[a] Daichi Oka,[ab] Kenichi Kaminaga,[c] Miho Kitamura,[de] Daisuke Shiga,[f] Hiroshi Kumigashira[df] and Tomoteru Fukumura*[agh]

[a] *Department of Chemistry, Graduate School of Science, Tohoku University, Sendai 980-8578, Japan*

[b] *Department of Chemistry, Graduate School of Science, Tokyo Metropolitan University, Tokyo 192-0397 Japan*

[c] *Department of Applied Chemistry, School of Engineering, Tohoku University, Sendai 980-8579, Japan*

[d] *Photon Factory, Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), Tsukuba 305-0801, Japan*

[e] *Institute for Advanced Synchrotron Light Source, National Institutes for Quantum Science and Technology (QST), Sendai, Miyagi 980-8579, Japan*

[f] *Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, Sendai 980-8577, Japan*

[g] *WPI Advanced Institute for Materials Research and Core Research Cluster, Tohoku University, Sendai 980-8577, Japan*

[h] *Center for Science and Innovation in Spintronics, Organization for Advanced Studies, Tohoku University, Sendai 980-8577, Japan*

* tomoteru.fukumura.e4@tohoku.ac.jp

Table S1 Film thickness of the NdO thin films in this study.

Film (Thickness)	Thickness from XRR		Figure
	NdO (nm)	Cap (nm)	
A (45 nm)	44.5 ± 1.4	7.6 ± 0.9	Fig. 7 (ΔM)
B (40 nm)	40.1 ± 3.0	5.9 ± 1.3	Fig. 1, 2, 4, 5, 6, 7 ($\Delta\sigma_{AHE}$), 8 Fig. S1, S2, S3
C (33 nm)	32.8 ± 0.8	5.9 ± 0.6	Fig. 3
D (19 nm)	18.6 ± 0.4	5.1 ± 0.8	Fig. 2, 7 (ΔM)
E (23 nm)	22.8 ± 1.6	6.5 ± 1.3	Fig. 1, 4, 5, 6, 7 ($\Delta\sigma_{AHE}$), 8 Fig. S1, S2, S3
F (12 nm)	12.3 ± 0.2	3.9 ± 0.9	Fig. 1, 2, 4, 5, 6, 7, 8 Fig. S1, S2, S3
G (9 nm)	9.3 ± 0.8	6.0 ± 1.6	Fig. 1, 2, 4, 5, 6, 7, 8 Fig. S1, S2, S3
H (3 nm)	3.1 ± 0.1	5.2 ± 0.1	Fig. 1, 2, 4, 5, 6, 7, 8 Fig. S1, S2, S3

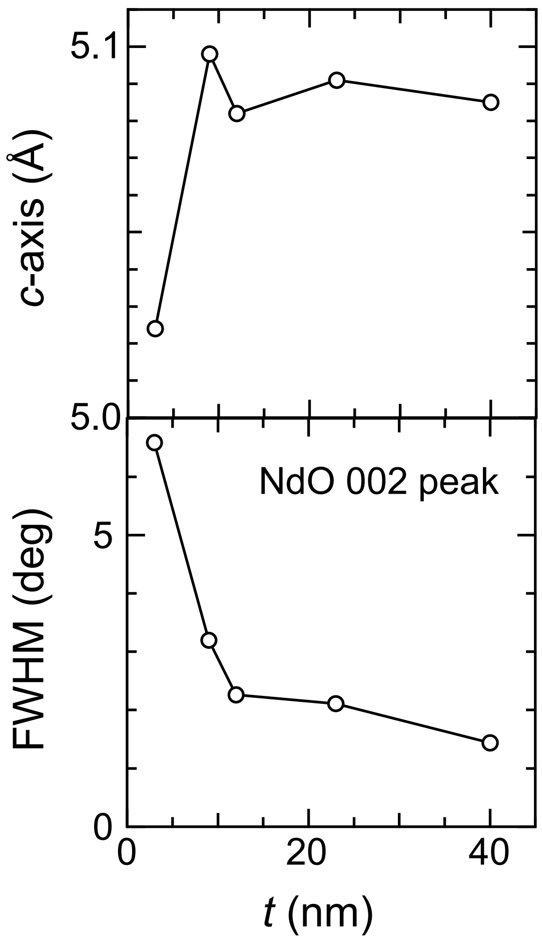

Fig. S1 Thickness dependence of the out-of-plane lattice constants calculated from the θ–2θ pattern and the full width at half maximum (FWHM) of the rocking curve around NdO 002 peak.

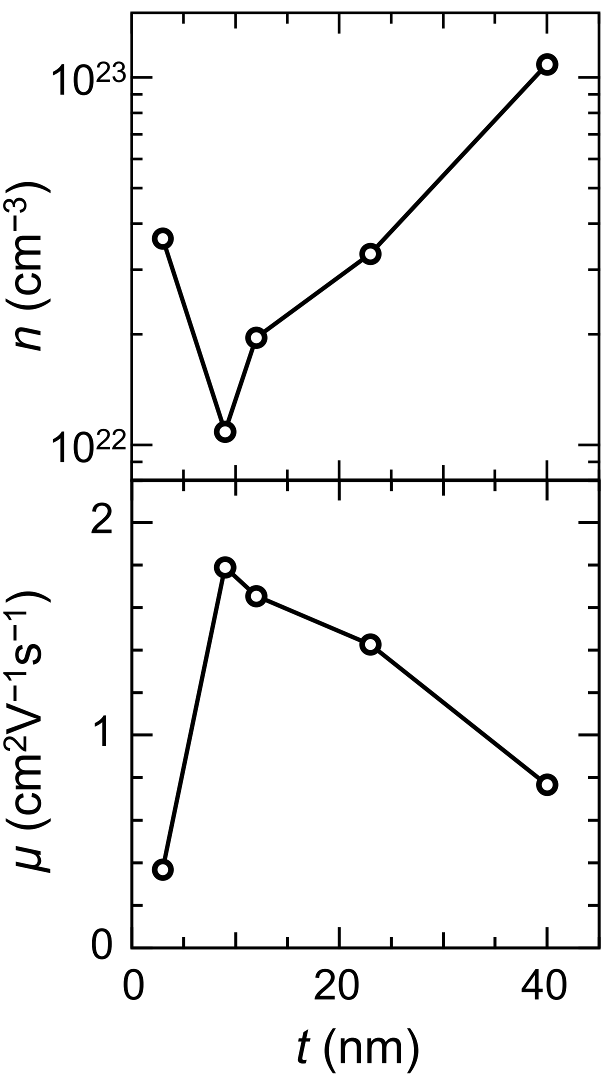

Fig. S2 Thickness dependence of carrier density and mobility calculated from the Hall coefficient at 300 K. It should be noted that the values include errors caused by the overlapping paramagnetic anomalous Hall effect.

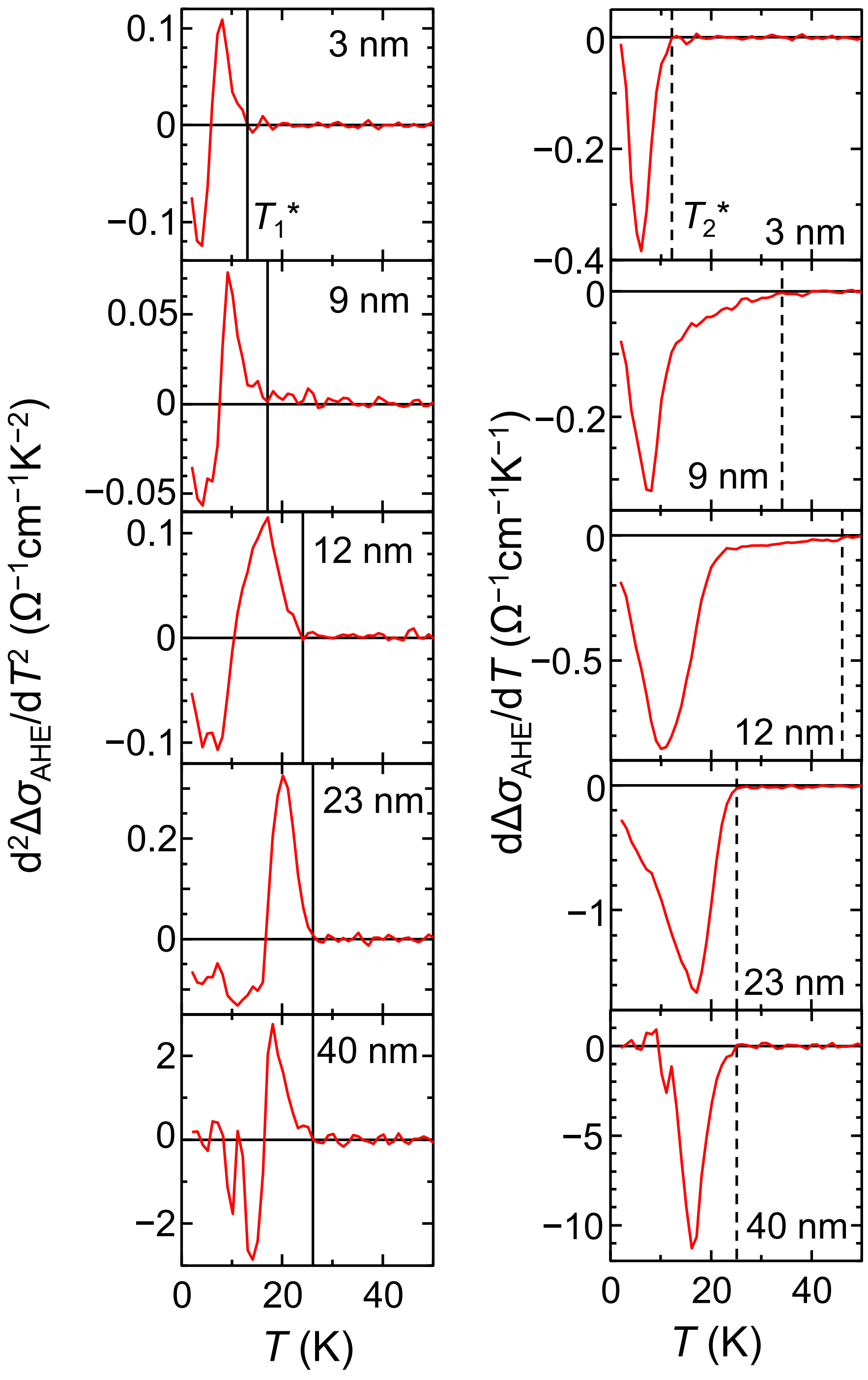

Fig. S3 Second and first temperature derivatives of $\Delta\sigma_{AHE}$ as a function of temperature. T_1^* and T_2^* were determined *x*-intercepts of $d^2\Delta\sigma_{AHE}/d^2T$ and $d\Delta\sigma_{AHE}/dT$, respectively.

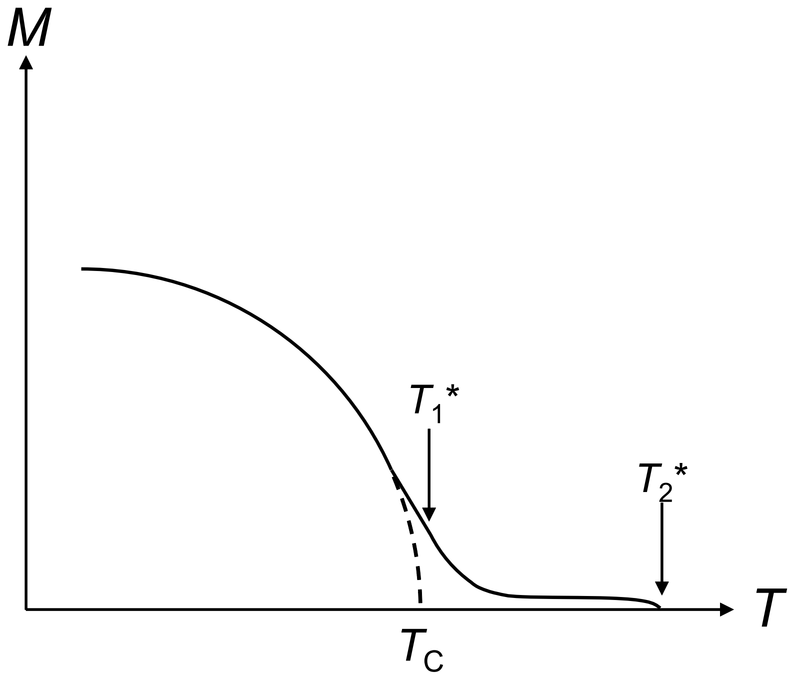

Fig. S4 Schematic *M*−*T* curve (solid line) and the correspondence with T_C, T_1^*, and T_2^*. T_1^* is the inflection point, approximately corresponding to the temperature at which the global magnetization starts increasing steeply. T_2^* corresponds to the onset of magnetization. Generally, T_1^* and T_2^* are similar, but become dissimilar when the weak ferromagnetic phase emerges. Dashed line is an extrapolation curve toward T_C. *M* and *T* are not to scale.