Supporting Information

Delta-temperatural electronic transportations achieved in metastable perovskites rare-earth nickelates thin films

Jikun Chen1, Haiyang Hu1, Takeaki Yajima2, Jiaou Wang1, Binghui Ge4, Hongliang Dong5, Yong Jiang1, and Nuofu Chen6

1Beijing Advanced Innovation Center for Materials Genome Engineering, School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing 100083, China
2School of Engineering, The University of Tokyo, 2-11-16 Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan
3Beijing Synchrotron Radiation Facility, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, China
4Institute of Physical Science and Information Technology, Anhui University, 230601, Heifei, Anhui, China
5Center for High Pressure Science and Technology Advanced Research, Shanghai 201203, China
6School of Renewable Energy, North China Electric Power University, Beijing 102206, China

Correspondence: Prof. Jikun Chen (jikunchen@ustb.edu.cn), Prof. Yong Jiang (yjiang@ustb.edu.cn) and Prof. Nuofu Chen (nfchen@ncepu.edu.cn); Request for materials: Prof. Jikun Chen (jikunchen@ustb.edu.cn).
Figure S1. The resistance of SmNiO$_3$ (SNO) on (a) LaAlO$_3$ (LAO), (b) SrTiO$_3$ (STO) and (c) (LaAlO$_3$)$_{0.3}$(Sr$_2$AlTaO$_6$)$_{0.7}$ (LSAT) substrates with a (001) orientation measured as a function of temperature.

Figure S2. The X-ray reciprocal space mapping of SmNiO$_3$ (SNO) grown on single crystalline perovskite structured substrates, such as LaAlO$_3$ (LAO), SrTiO$_3$ (STO) and (LaAlO$_3$)$_{0.3}$(Sr$_2$AlTaO$_6$)$_{0.7}$ (LSAT) with (001) orientation via the chemical approach reported previously. The reciprocal vector of (114) is used to probe the diffraction patterns from both the thin film and the substrate.
Figure S3. The temperature dependence in resistivity for SmNiO$_3$/LaAlO$_3$, SmNiO$_3$/SrTiO$_3$, and SmNiO$_3$/$(La, Sr)(Al, Ta)O$_3$, measured via heating up (solid lines) and cooling down (dash lines). A lower metal to insulator transition temperature ($T_{MIT}$) is observed for the bi-axial distorted SmNiO$_3$/$(La, Sr)(Al, Ta)O$_3$, compared to the partially tensile strain relaxed SmNiO$_3$/SrTiO$_3$, and SmNiO$_3$/$(La, Sr)(Al, Ta)O$_3$. These observations are in agreement to the previous reports on strain distorted SmNiO$_3$. 


Figure S4. (a) The X-ray reciprocal space mapping of SmNiO$_3$ (SNO) grown on single crystalline SrTiO$_3$ (STO) with (001) orientation via pulsed laser deposition. The reciprocal vector of (114) is used to probe the diffraction patterns from both the thin film and the substrate. (b) The interfacial morphology of as-grown SmNiO$_3$/SrTiO$_3$ from the high-angle annular dark-field (HAADF) images. (c) Temperature dependence of the resistivity and (d) Temperature coefficients of resistance (TCR) for as-grown SmNiO$_3$/SrTiO$_3$. 
Figure S5. The resistance of ReNiO$_3$ grown on the LaAlO$_3$ (001) substrate with single and multiple rare earth compositions measured as a function of temperature.

Figure S6. Resistance of YNiO$_3$ measured as a function of the imparted external magnetic fields ($B$) at various temperatures.
Figure S7. (a) The maximum resistivity at $T_{R-MIT}$ compared to the one at 300 K, and (b) the full widths half maximum of its resultant delta-shaped temperature dependence in resistivity ($T_{\text{Delta}}$-FWHM) summarized from the $R-T$ of multiple rare-earth composition perovskite nickelates shown in Figure 4a.