Supplementary

Role of electron and hole doping in $NdNi_{1-x}V_xO_3$ Nanostructure

Raktima Basu*[a], Reshma Kumawat[a], Mrinmay Sahu[a], Abu Bakkar Miah[b], Partha Mitra[b], and Goutam Dev Mukherjee[a]

[a]*National Centre for High Pressure Studies, Department of Physical Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur Campus, Mohanpur 741246, Nadia, West Bengal, India*
[b]*Department of Physical Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur Campus, Mohanpur 741246, Nadia, West Bengal, India*

Sample S_3 and S_4 were synthesized with higher doping concentration of V. The EDX data confirms that V mostly replaces Ni ion as $NdNi_{1-x}V_xO_3$ (x ~0.025 for S_3 and ~0.04 for S_4).

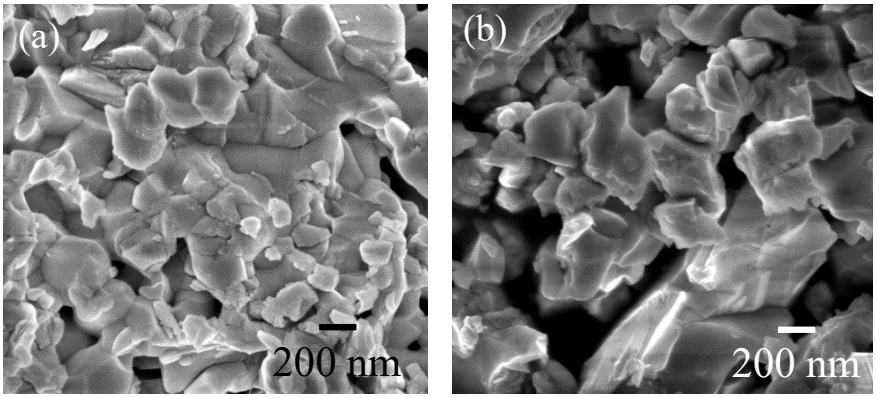

Fig. S1 FESEM images for the pristine samples S_3, and S_4

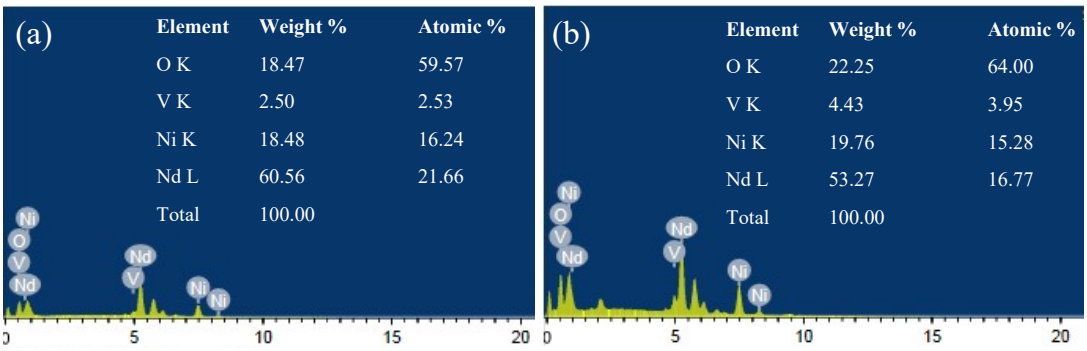

Fig. S2 EDX spectra for the samples S_3 and S_4. Insets show the elemental composition of each sample with corresponding atomic percentages.

We have performed the X-ray photoelectron spectroscopic (XPS) technique in an ultra-high vacuum (UHV) chamber (Omicron Nanotechnology, of base pressure ~1.5×10^{-9} mbar). The UHV system was equipped with an EA125 hemispherical energy analyser along with a monochromatic X-ray light source (Al Kα of photon energy 1486.6 eV). All the data were collected keeping the samples at room temperature.

The upper panel of figure S3 shows the XPS peaks correspond to Nd3d, Ni2p and O1s transitions.

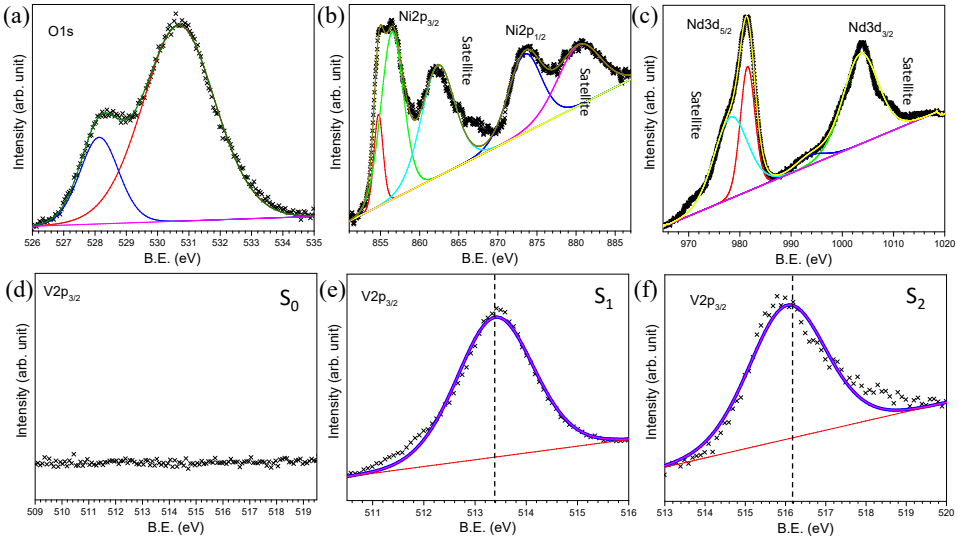

Fig. S3 High resolution XPS spectra of the sample S_0, S_1, and S_2 with corresponding electronic transition of different elements.

The O1s region (figure S3a) shows peaks around 528.3 and 531 eV which can be ascribed to the sample and surface contamination, respectively [R1]. Figure S3b shows the $Ni2p_{3/2}$ peak ~856 eV and $Ni2p_{1/2}$ peak ~873 eV, which corresponds to trivalent Ni [R2]. We also observed characteristic satellites at about 862 and 880 eV. The Nd3d level spectra (figure S3c) shows peaks ~882 and 1004 eV correspond to $Nd3d_{5/2}$ and $Nd3d_{3/2}$ transitions, respectively. We were also able to observe the low binding energy satellites, which is the characteristic feature of Nd multiplet [R3]. For all the three samples we observe similar spectra for Nd, Ni, and O. However, the position of V lines varies for samples S_1, and S_2. The lower panel of figure S3 displays the existence of V and its corresponding valence state. Sample S_1 and S_2 confirms the presence of Vanadium, whereas for sample S_0, no trace of V is observed (figure S3d). The V $2p_{3/2}$ peak is observed ~ 513.4 eV for sample S_1, whereas the same is observed ~ 516.2 eV for sample S_2 (figure S3e-f). The position of V $2p_{3/2}$ peak confirms that V is in +2 state [R4] in sample S_1, where as it is in +4 state [R5] in sample S_2, as also argued from resistivity, Raman spectroscopic and XRD analysis.

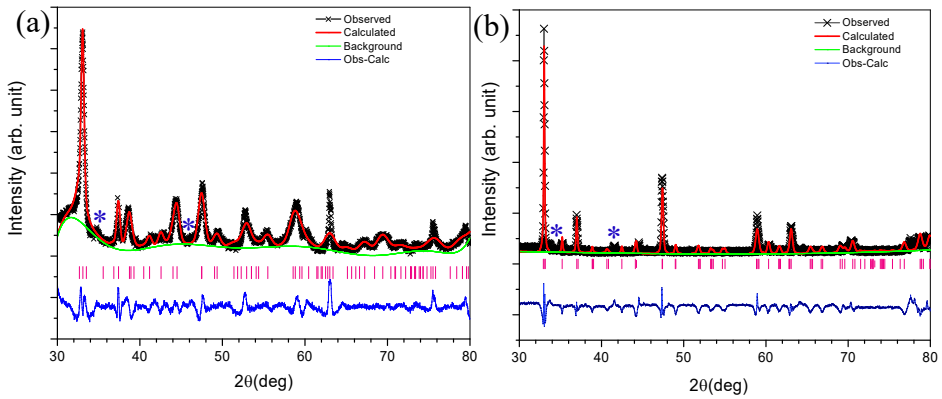

Fig. S4 Rietveld refined X-ray diffraction pattern of samples (a) S_3, (b) S_4. Impurity peaks are marked by '*' sign.

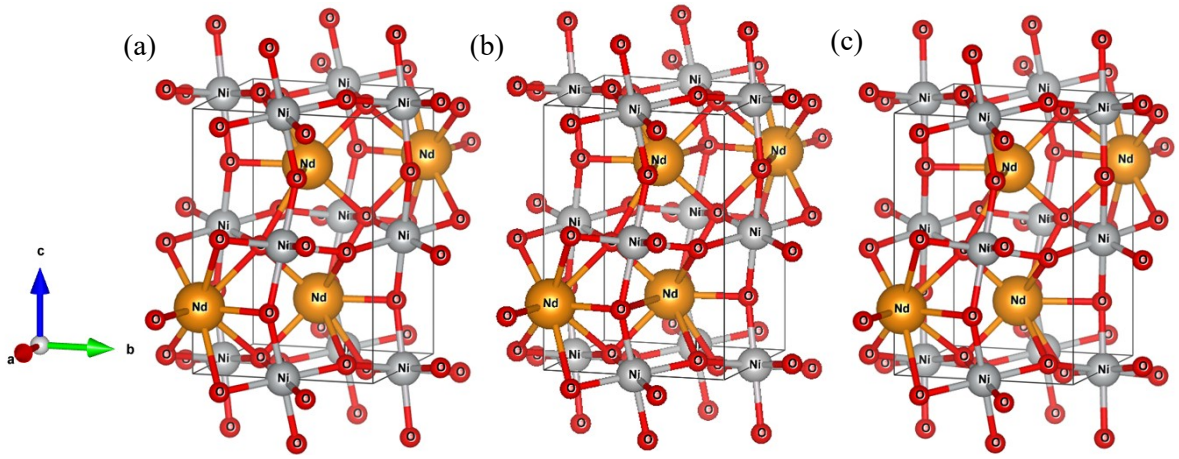

Fig. S5 Schematic structure of $NdNi_{1-x}V_xO_3$ unit cell of sample (a) S_0 (x=0.0), (b) S_1 (x=0.1), and (c) S_2 (x=0.2), drawn using VESTA software.

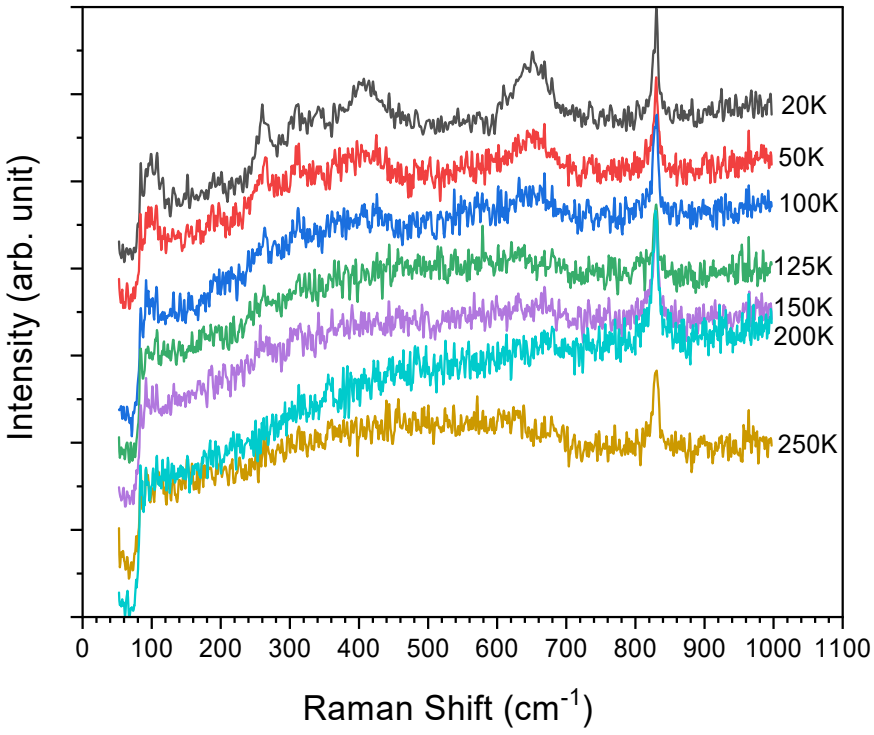

Fig. S6 Raman spectra as a function of temperature for $NdNi_{1-x}V_xO_3$ (x = 0.01) nanostructure (sample S_1)

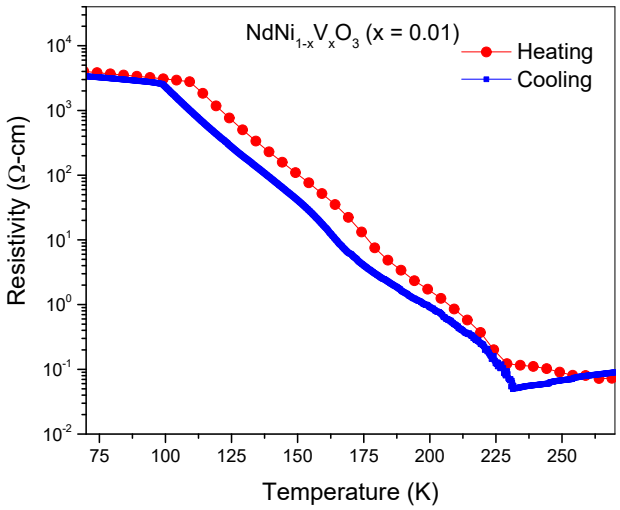

Figure S7. Resistivity plots as a function of temperature for $NdNi_{1-x}V_xO_3$ (x = 0.01) nanostructure for both heating and cooling cycle with a hysteresis ~ 10 K.

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