Supporting Information for

Sodiation vs. Lithiation Phase Transformations in a High Rate - High Stability SnO_2 in Carbon Nanocomposite

Jia Ding[a], Zhi Li[a], Huanlei Wang[a], Kai Cui[b], Alireza Kohandehghan[a], Xuehai Tan[a], Dimitre Karpuzov[c], David Mitlin [d, a *]*

[a]Chemical and Materials Engineering, University of Alberta, Edmonton, Alberta T6G 2V4, Canada

[b]National Institute for Nanotechnology (NINT), National Research Council of Canada, Edmonton, Alberta T6G 2M9, Canada

[c] Alberta Center for Surface Engineering and Science (ACSES), University of Alberta, Edmonton, AB, Canada T6G 2G6

[d] Chemical & Biomolecular Engineering and Mechanical Engineering, Clarkson University, Potsdam, NY, USA 13699

*Address correspondence to dingjiasiom@gmail.com (J. Ding); dmitlin@clarkson.edu (D. Mitlin).

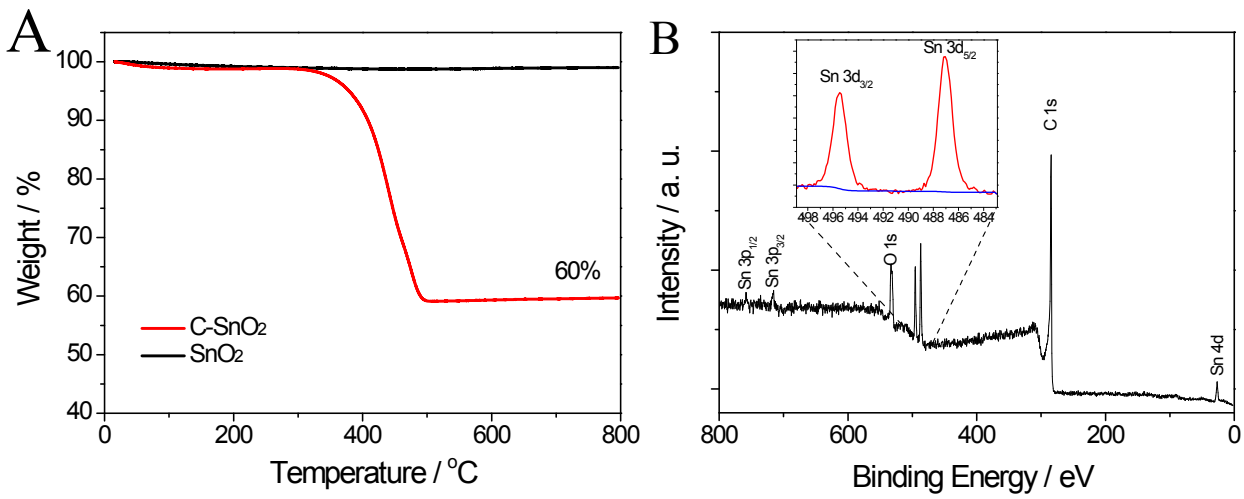


Figure S1: (A) Thermogravimetric curves of C-SnO_2 and SnO_2 specimens. (B) XPS survey spectrum of C-SnO_2 and high resolution spectrum of Sn 3d level (insert).

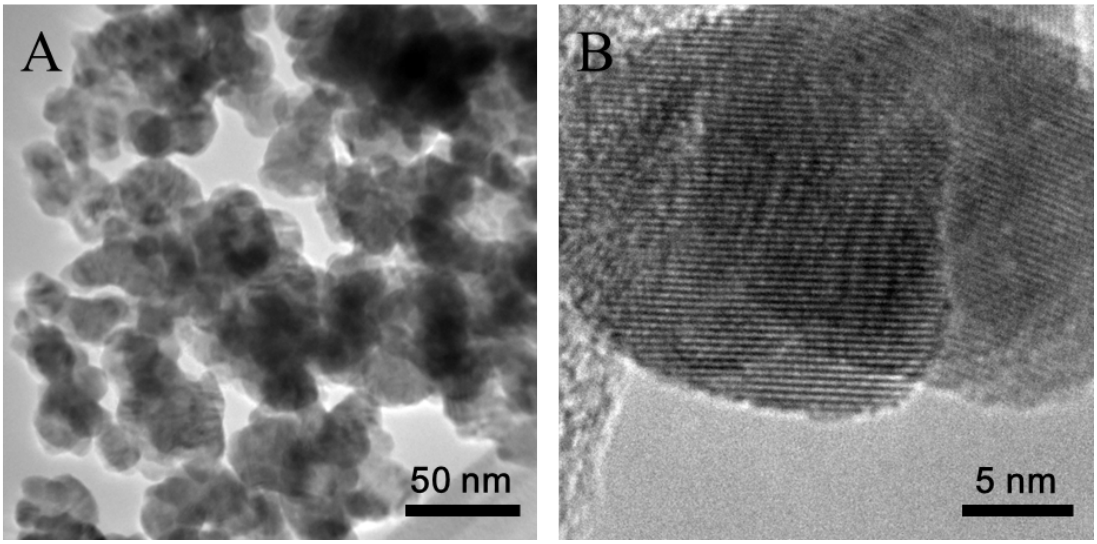


Figure S2: (A) Conventional TEM micrograph of the baseline SnO_2 specimen. (B) HRTEM micrograph of two overlapping SnO_2 particles.

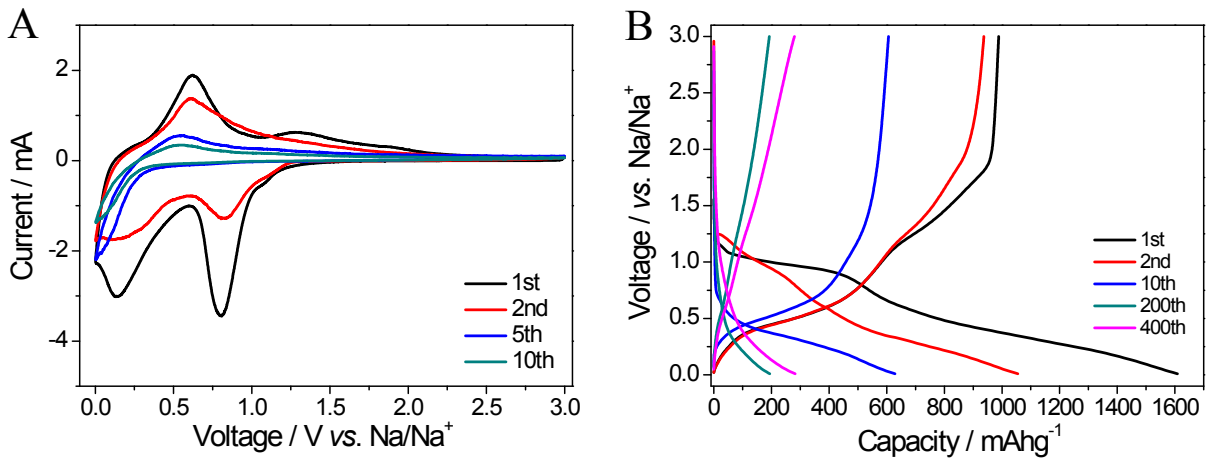


Figure S3: Electrochemical performance of SnO_2 *vs*. Li. (A) CVs of SnO_2, tested at 0.1 mVs^{-1}. (B) Galvanostatic discharge/charge profiles of SnO_2, tested at $0.5Ag^{-1}$.

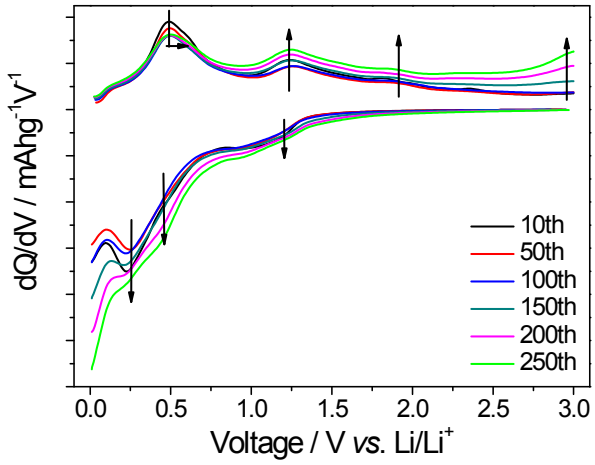


Figure S4: Derivate curves dQ/dV *vs*. V for C-SnO_2 electrode against Li.

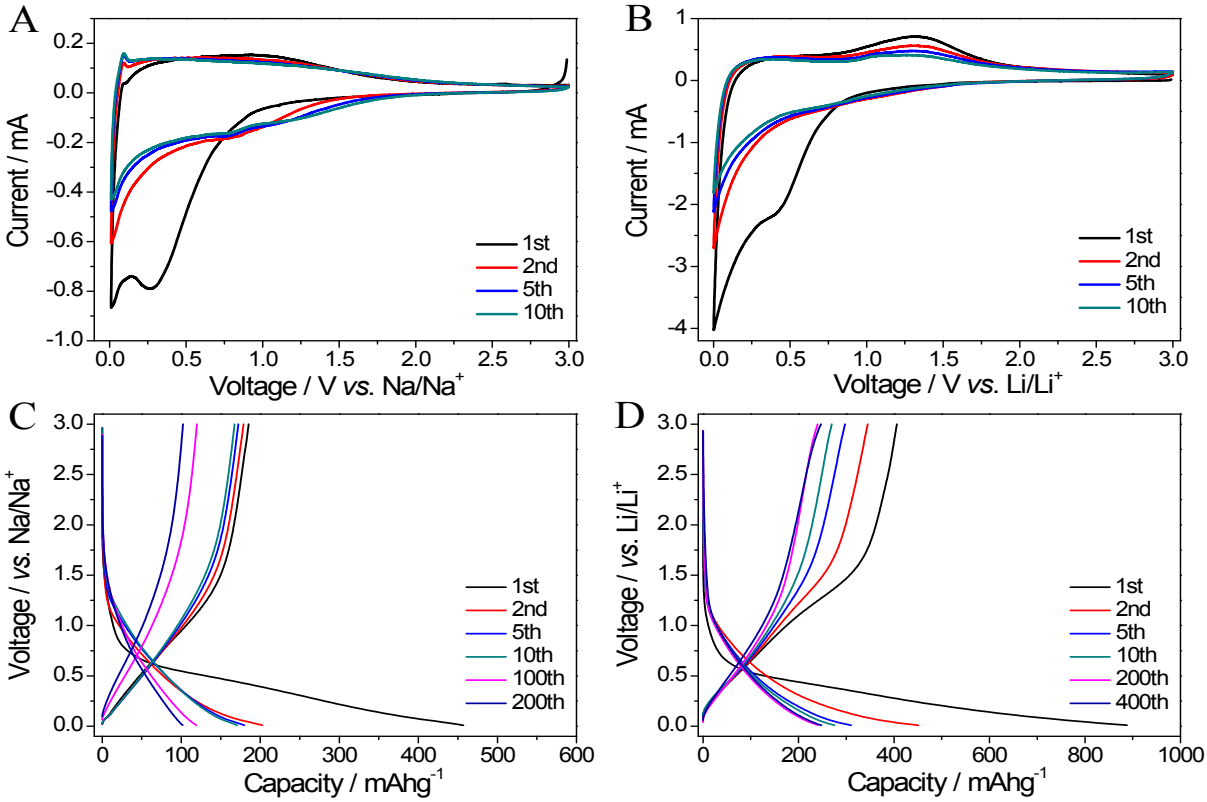


Figure S5: Electrochemical performance of pure carbon in a half-cell *vs*. Na, Li. (A) CVs of pure carbon electrode for the cycle 1 – 10 *vs*. Na, tested at 0.1 mVs^{-1}. (C) Galvanostatic discharge/charge profiles of pure carbon electrode, tested at 0.08 Ag^{-1}. (B) CVs of pure carbon electrode for the cycle 1 – 10 *vs*. Li, tested at 0.1 mVs^{-1}. (D) Galvanostatic discharge/charge profiles of pure carbon electrode, tested at 0.5 Ag^{-1} *vs*. Li.

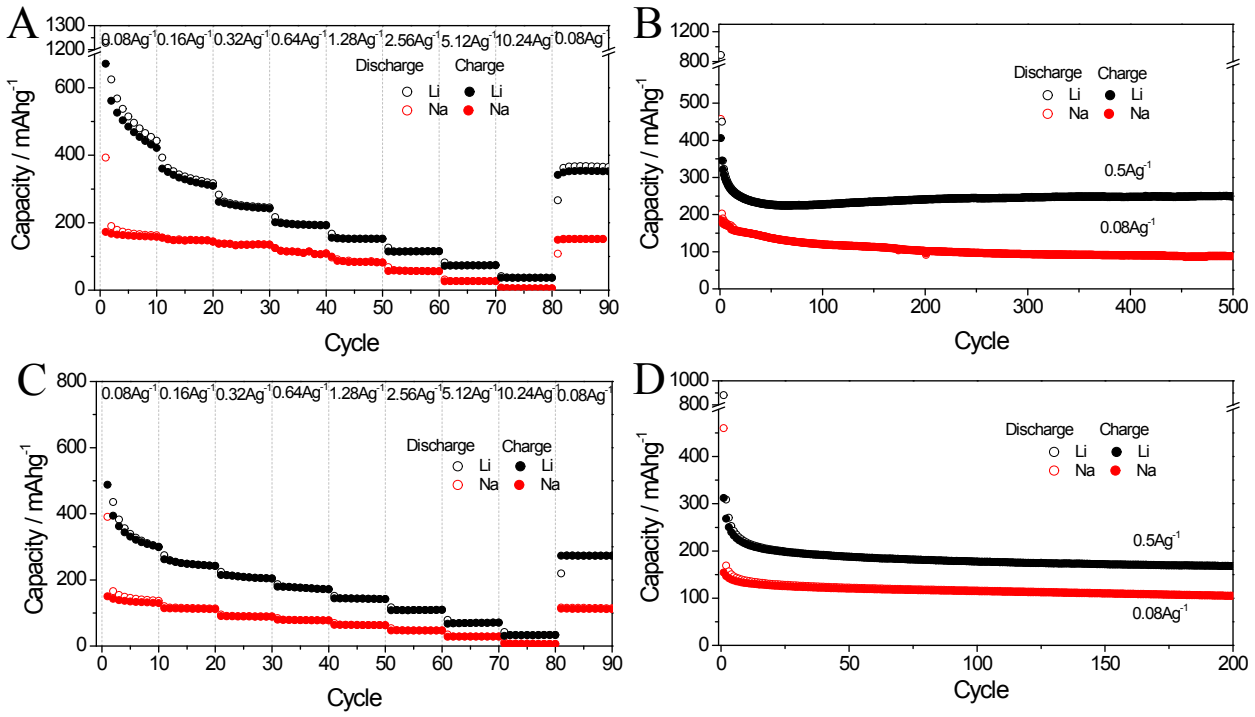


Figure S6: (A) Rate performance of the baseline pure amorphous carbon electrodes *vs*. Na and *vs*. Li, tested 0.01-3V. (B) Cycling performance of pure carbon electrodes, tested 0.01-3V. (C) Rate performance of the baseline pure amorphous carbon electrodes *vs*. Na and *vs*. Li, tested 0.01-1.5V. (D) Cycling performance of pure carbon electrodes, tested 0.01-1.5V.

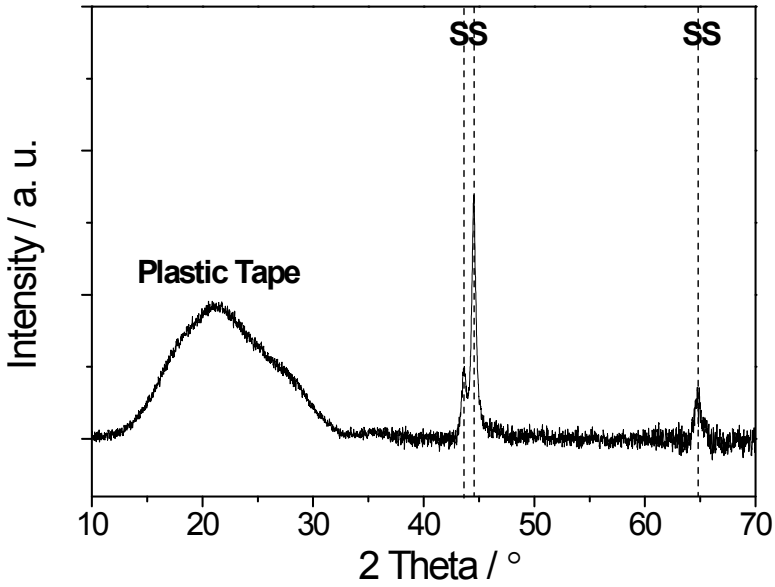


Figure S7: XRD pattern for the plastic tape on the stainless steel current collector.

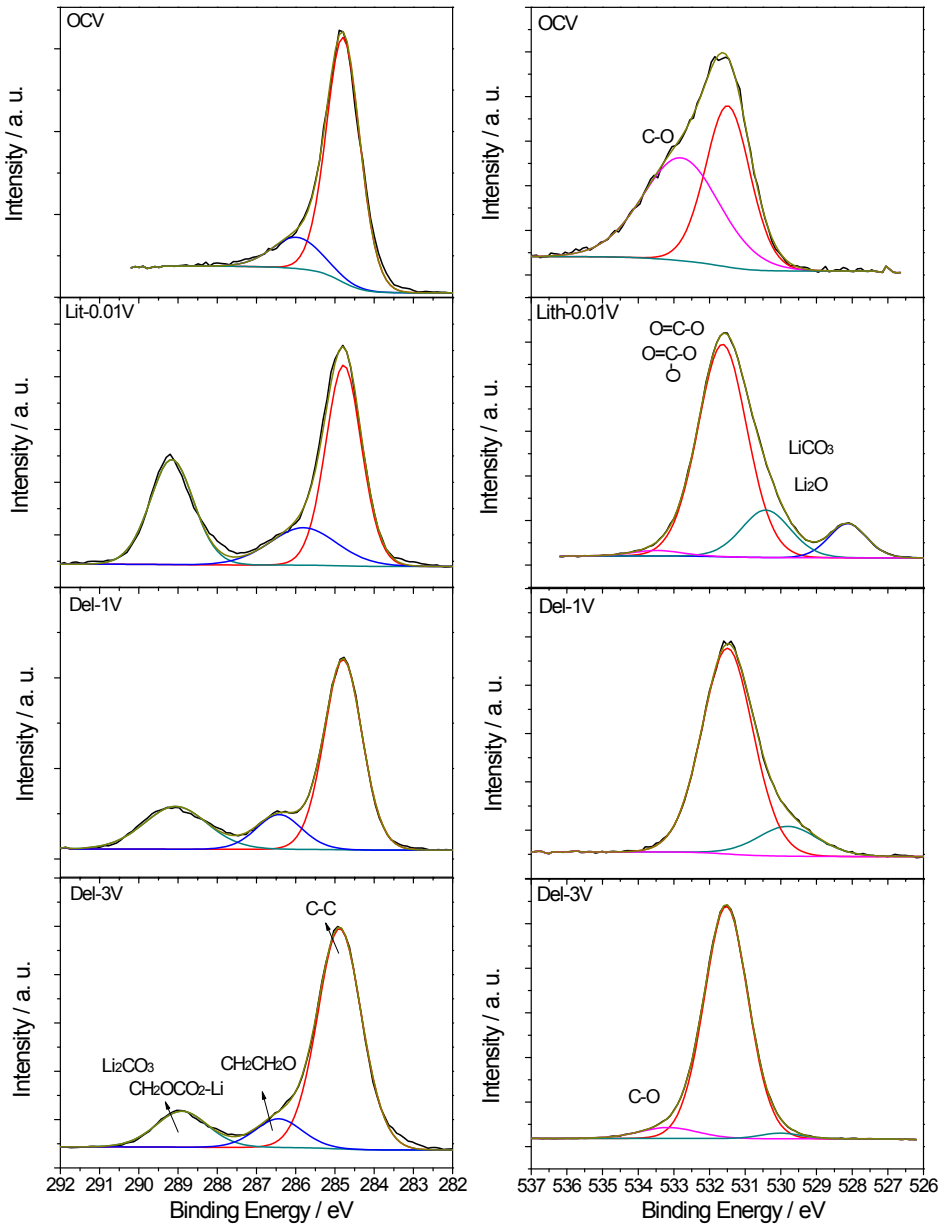
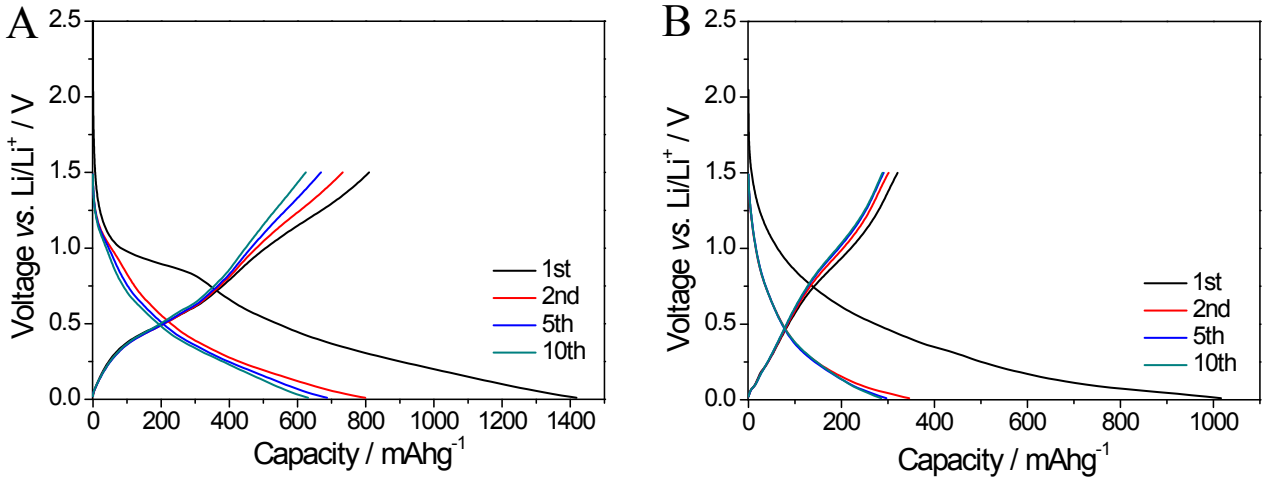


Figure S8: XPS spectra for C 1s (left) and O 1s (right) of C-SnO_2 electrodes at the same cut-off voltages.


A
B
Voltage vs. Li/Li+ / V
Capacity / mAhg-1
1st
2nd
5th
10th

(A) and Na (B) between 0.01 and 1.5V tested at current density of $80mAg^{-1}$.

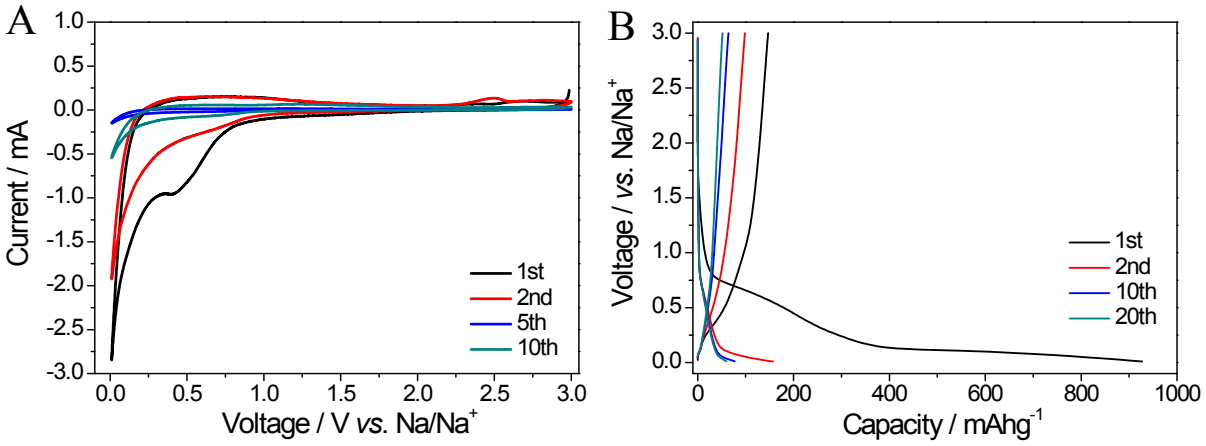


Figure S10: Electrochemical performance of SnO_2 *versus* Na. (A) Cyclic voltammograms (CVs) of SnO_2 electrode. (B) Galvanostatic discharge/charge profiles of SnO_2 electrode at current density of $0.08Ag^{-1}$.

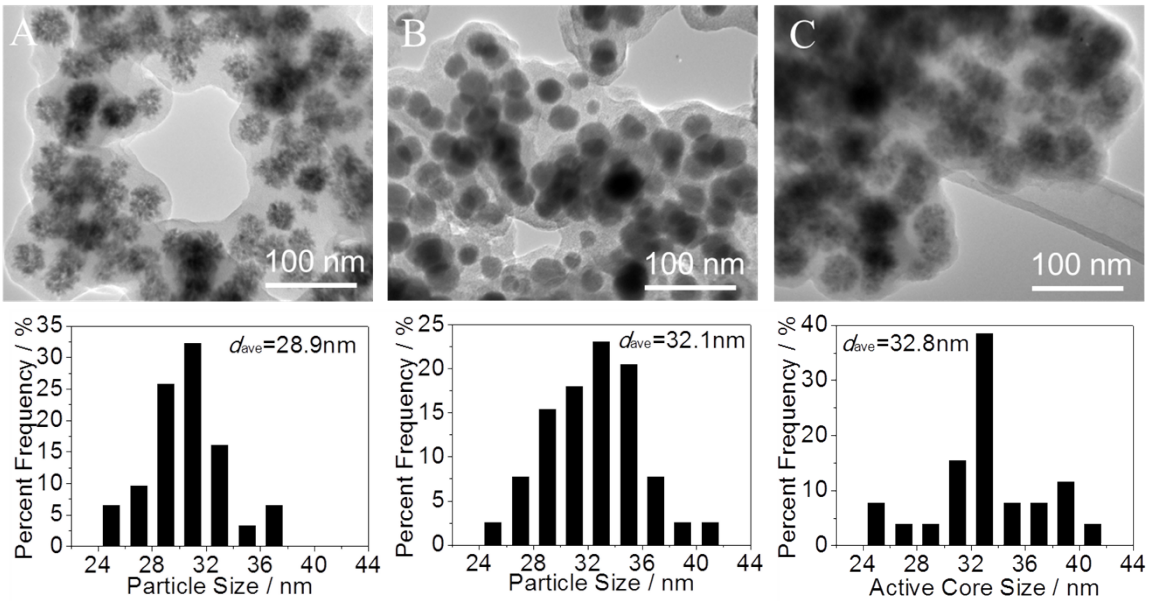


Figure S11: (A-C) TEM micrographs of C-SnO_2 with corresponding histograms for the size of the active SnO_2 nanocrystal assemblies (not individual crystallites). (A) Open circuit potential. (B) Sodiated to 0.01V. (C) Desodiated to 3V.

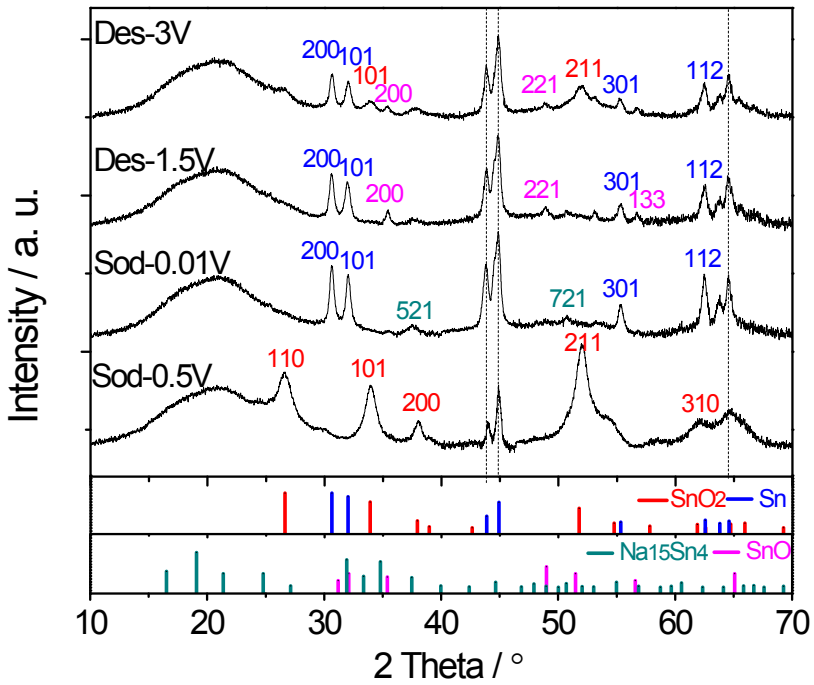


Figure S12: (A) XRD patterns of SnO_2 electrodes at various cut-off voltages: first sodiation to 0.5V, first sodiation to 0.01 V, first desodiation to 1.5V, first desodiation to 3V.

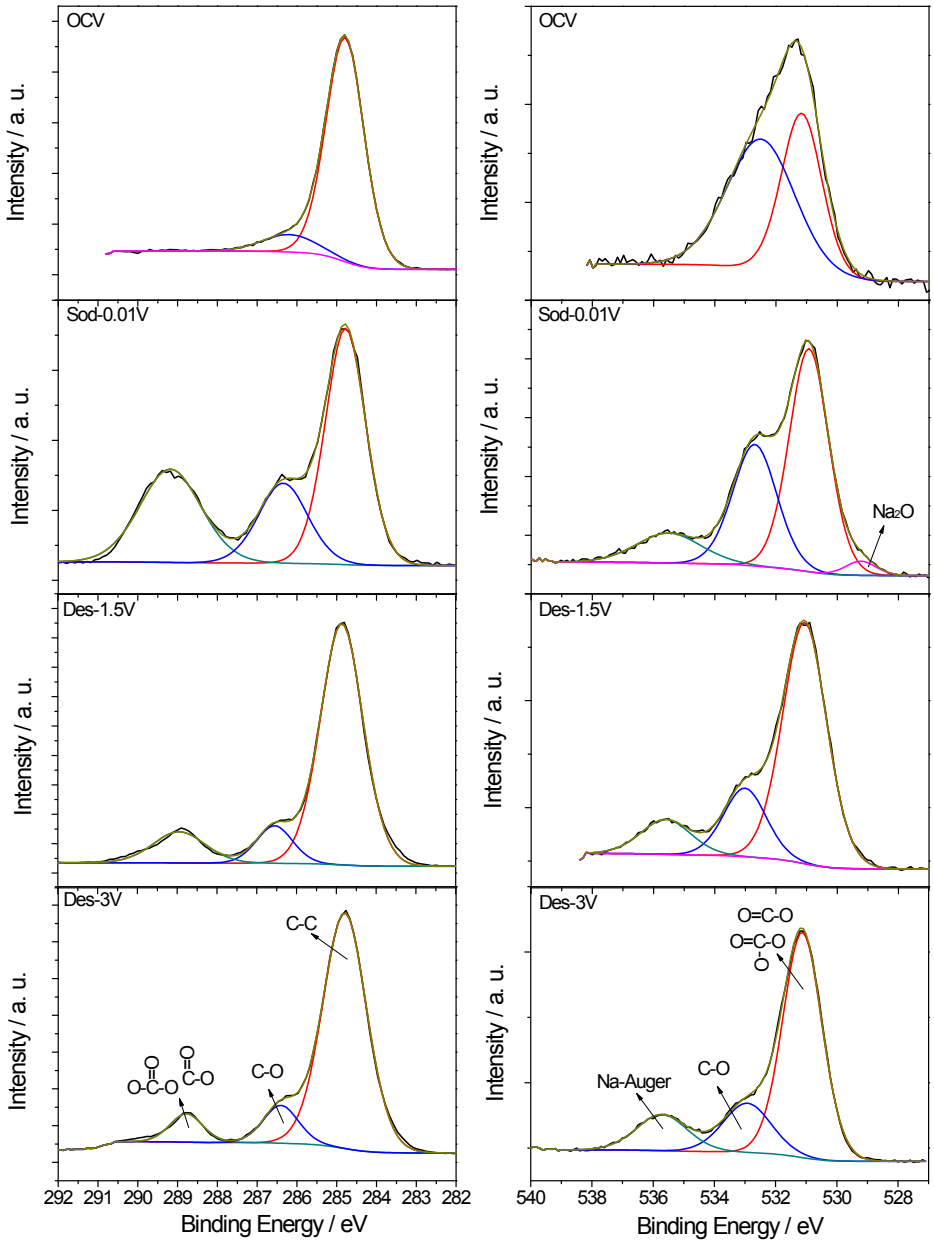


Figure S13: XPS spectra for C 1s (left panel) and O 1s (right panel) levels of C-SnO_2 electrodes at various cut-off voltages (open circuit voltage, first sodiated to 0.01 V, first desodiated to 1.5V, first desodiated to 3V *vs*. Na/Na^+.