Electronic Supplementary Material (ESI) for RSC Advance

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Supporting Information: V_2O_5 Array Cathode: Structural Effect on Lithium Ion Batteries Performance

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Experimental section

Preparation of V_2O_5 nano structure arrays

Titanium foil (99.5% purity) and metallic Li foil (battery grade) were purchased from Guangzhou Instrument Co. Ltd (China) and Shenzhen Instrument Co. Ltd (China), respectively. Sodium vanadate, hydrochloric acid, phosphoric acid, oxalic acid was obtained from Beijing Chemistry Instrument Co. Ltd (China) without any further purification.

The growth solutions were prepared by dissolving 1 mmol of sodium vanadate in 35 ml distilled water with continuous stirring at room temperature. Then the pH value was adjusted to about 2.0 by adding a certain amount of hydrochloric acid, phosphoric acid or oxalic acid, separately.

A Ti foil with size of 1×4 cm^2 was sonically cleaned by hydrochloric acid, D.I. water and pure ethanol subsequently each for 10 min. Afterward, the Ti foil was tilted against the wall of the autoclave at a certain angle, with the interested surface facing down. The earlier prepared precursor solution was slowly poured into the autoclave. The autoclave was then tightly sealed and left in an oven at 120 ℃for 12 h for reaction. After cooling to room temperature naturally, the Ti foil was taken out, rinsed with DI water and ethonal several times and dried at 80 ℃for 30min. Then, the samples were further annealed in a tube furnace in N_2 at 400 ℃ for 2h.

Structural and electrochemical characterization

The samples were characterized by X-ray powder diffraction (XRD) with a Japan Rigaku Dmax X-ray diffractometer equipped with graphite monochromatized high-intensity Cu KR radiation (λ=1.54178A). The transmission electron microscopy (TEM) images were obtained by a Hitachi Model H-800 instrument with a tungsten filament, using an accelerating voltage of 200 kV. High-resolution transmission electron microscopy (HRTEM) images and electron diffraction (ED) patterns were carried out on a JEOL-2100 transmission electron microscope at an acceleration voltage of 200 kV. The field emission scanning electron microscopy (SEM) images were taken on a ZEISS SUPRA55 scanning electron microscope. X-ray photoelectron spectroscopy (XPS) spectrum was collected on SSI S-Probe XPS Spectrometer. Raman spectrum of powder samples were recorded on LabRAM HR Raman microscope with a laser excitation wavelength of 632.8nm.

The V_2O_5 nanostructure arrays on the current collector were used as anodes directly. Coin-type half cells (2016R type) were fabricated to evaluate the electrochemical properties of all types of the V_2O_5 as working electrodes. 1 M $LiPF_6$ in ethylene carbonate/diethylene carbonate was used as the electrolyte. Pure Li foil was accepted to serve as a counter electrode and reference electrode. The cell was assembled in an argon-filled glove box where moisture and oxygen concentrations were strictly limited to below 0.1 ppm. The galvanostatic cycling was performed on a LAND battery testing system in model of 5V 1mA and cyclic voltammetry (CV) was collected using electrochemical workstation (Chenhua Co.Ltd, China, CHI600D) in a three-electrode cell.

Figures and Captions

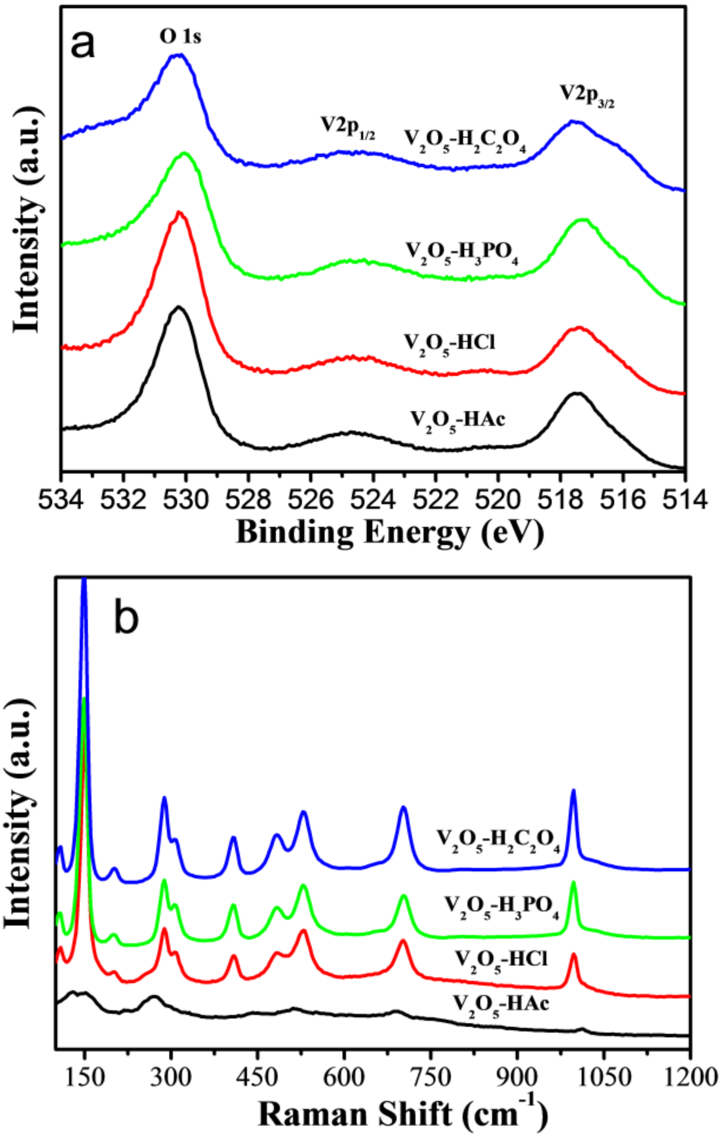

Fig. S1 Raman (a) and XPS (b) of the V_2O_5-HAc, V_2O_5-HCl, V_2O_5-H_3PO_4 and V_2O_5-$H_2C_2O_4$

The well-resolved spectrum exhibits several peaks at about 149, 201, 288, 305, 407, 482, 529, and 702 cm-1, corresponding to the sequence observed for V2O5 single crystals and polycrystalline films. The prominent peak at 149 cm-1 is attributed to the skeleton bent vibration. It has been related to a deformation of the bond between different molecular units in the plane of the layers.

The binding energies of V 2p3/2 and V 2p1/2 were found to be 517.1 and 524.5 eV, which were the characteristic for vanadium (V), while the O 1s peak existed at 530.2 eV which was attributed to V=O stretch.

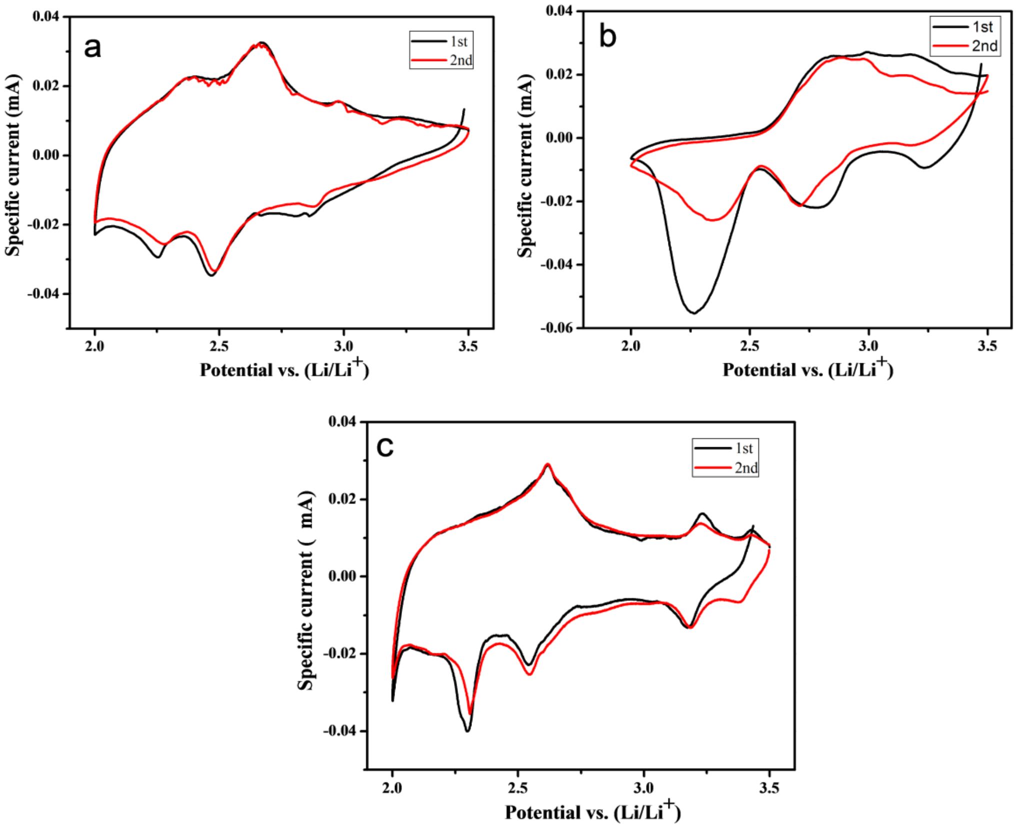

Fig. S2 CV curves for the first two cycles of V_2O_5-HCl (a), V_2O_5-H_3PO_4 (b) and V_2O_5-$H_2C_2O_4$ (c) electrode at a scan of 1mV s^{-1}

Tab. S1 The calculated crystal domain sizes

Samples	*Dc/nm*
V_2O_5-HCl	29.3
V_2O_5-H_3PO_4	41.5
V_2O_5-$H_2C_2O_4$	47.2

The latter can be used for crystal domain size calculation based on Sherrier Equation ($Dc= 0.89\ \lambda / (B \cos\theta)$).

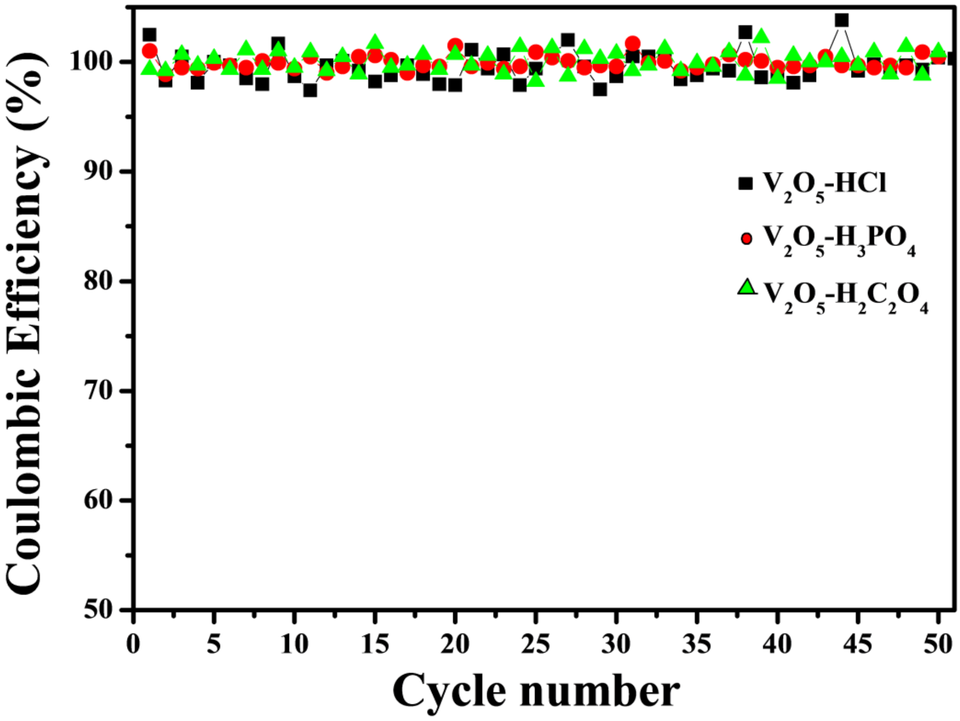

Fig. S3 Coulombic efficiency of the V_2O_5 electrode

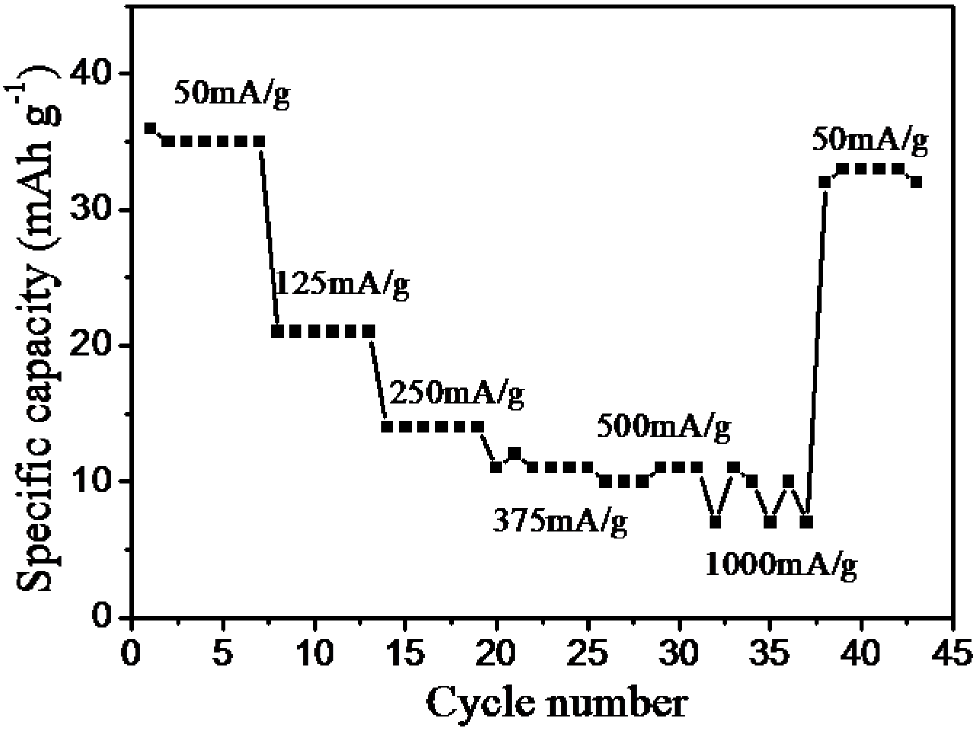

Fig. S4 Cycling performance of V_2O_5–HAc at different current densities indicated