

Impact of Large-Scale Meso- and Macropore Structure in Adenosine-derived Affordable Noble Carbon on Efficient Reversible Oxygen Electrocatalytic Redox Reaction

Ken Sakaushi,* Seung Jae Yang, Tim-Patrick Fellingner, Markus Antonietti

Max-Planck-Institute of Colloids and Interfaces, Colloid Chemistry Department,

Scientific Park Potsdam-Golm, D-14476 Potsdam, Germany

*Correspondence to: K.S. (Sakaushi.ken@nims.go.jp)

Contents

Experimental

Supplementary Figure S1: XPS measurements for APNCs

Supplementary Figure S2: Raman spectroscopy measurements for APNCs

Supplementary Figure S3: TEM observation for APNC-3

Supplementary Figure S4: Overpotentials of APNCs at discharge.

Supplementary Figure S5: Overpotentials of APNCs at recharge.

Supplementary Table S1: The detail amounts of nitrogen in APNCs.

Experimental

Material synthesis: The APNCs were synthesized adding adenosine to a binary salt mix (a combination of KCl and ZnCl₂ with the mass ratio of 1.00 to 1.75). The “salt-melt synthesis” as a template procedure enables to control the pore volume in carbonaceous materials with high specific surface area by just changing the ratio of starting material and a salt. The adenosine was purchased from Aldrich and used without further purification.

1 g of adenosine was mixed with the binary salts. We chose three ratio of adenosine and salts (A:S) as A:S = 5:1 (described as APNC-1), A:S = 5:2.5 (APNC-2), and A:S = 5:5 (APNC-3). Then, the samples were carbonized at 1000 °C for two hours under N₂ flow, washed with distilled water overnight, and obtained three different APNCs. After cooling, the resulting dark solid was ground into a powder, and then was washing with water for several times, centrifugation to recover the powders. We repeat this procedure twice. Finally, the products were dried at 60 °C overnight in vacuum. The resultant materials were characterized by X-ray diffractometer (D8 Advance, Bruker) with Cu Kα₁ radiation source. Elemental Analysis was performed on a Vario Micro setup to determine the carbon, nitrogen and hydrogen contents of the samples. TEM images were taken on an EM Omega 912X (Zeiss) at an acceleration voltage of 120 kV. BET surface areas and pore volumes were obtained from 77 K N₂ sorption isotherms using ASAP 2010 instrument, with samples previously evacuated at 150 °C for 20 h. XPS spectrum were collected by operating an AXIS-His (KRATOS).

Electrochemistry: Electrodes were made by mixing the active material (80 wt.%) and binder (PVDF; 20 wt.%). We used Ni foam as current collectors. The loading mass was ~2 mg. We assembled the cells in a purge-type dry glove box (M Braun) filled with high purity Ar gas and tested them on a multichannel potentiostatic-galvanostatic system (VMP-3, Bio-logic). We used lithium metal as a counter and a reference electrode. The lithium metal at the counter electrode was protected by a glass fiber sheet. Before assembling the cell, all equipment and electrode were dried at 150 °C for at least 5 h under vacuum. We used 1 M LiTFSI in TEGDME (Solvionic) as an electrolyte, and a two-electrode -type cell with supply of pure O₂ to the cathode without any contact with ambient air. LiTFSI was dried at 180 °C for 24 h under vacuum. TEGDME was transferred into an Ar filled glove box without any exposure to air. The distilled solvents were stored over activated type 4Å molecular sieves in an Ar-filled glove box. The molecular sieves were washed with acetone and dried in the oven at 200 °C under vacuum for 72 h.

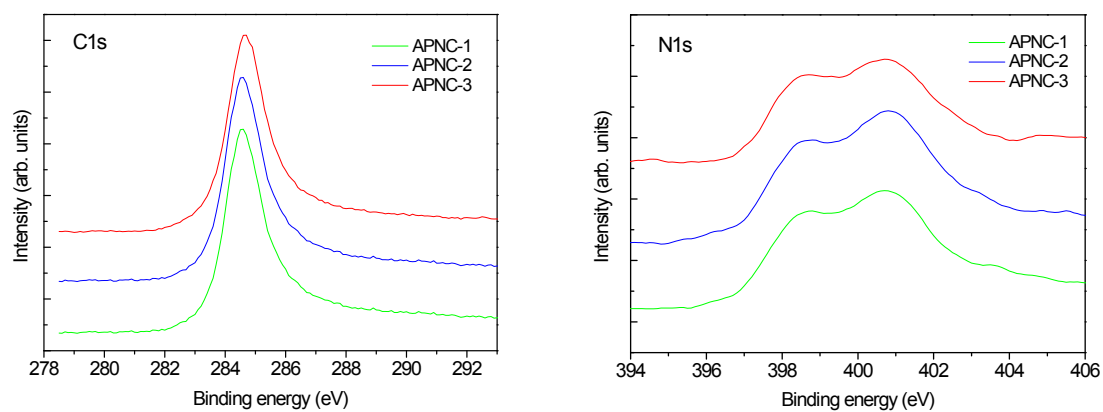


Figure S1. XPS measurements for APNCs.

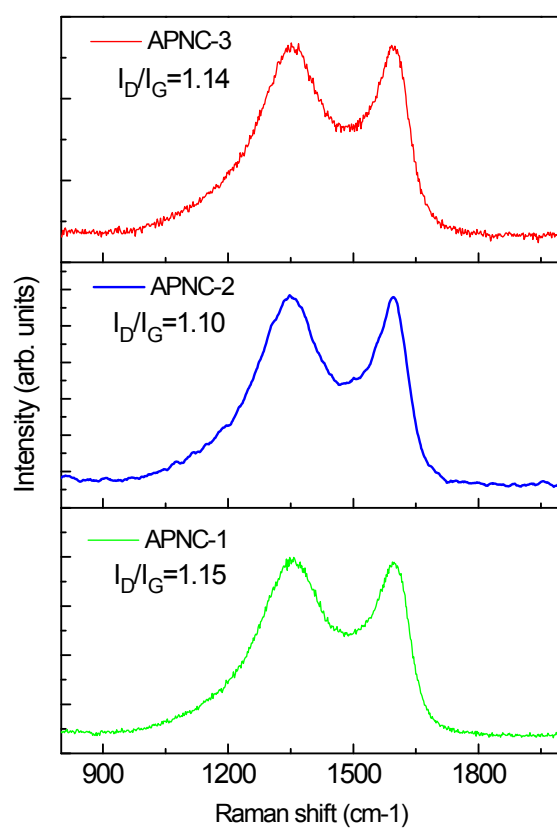


Figure S2. Raman spectra for APNCs

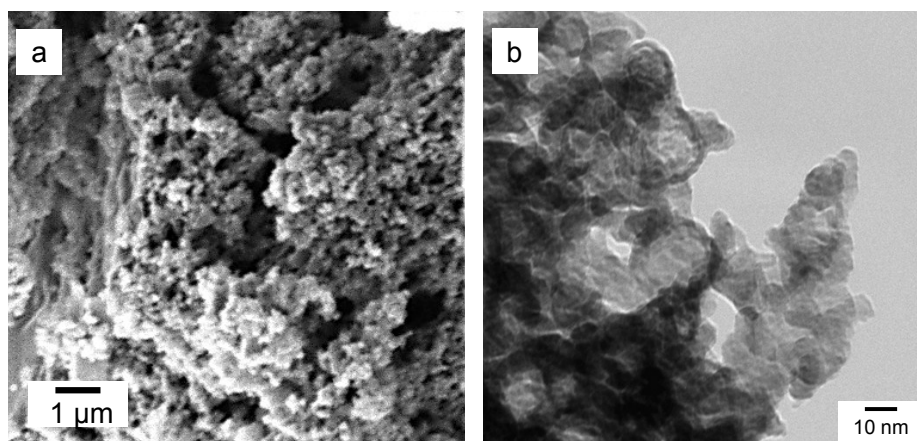


Figure S3. SEM and TEM observation for APNC-3.

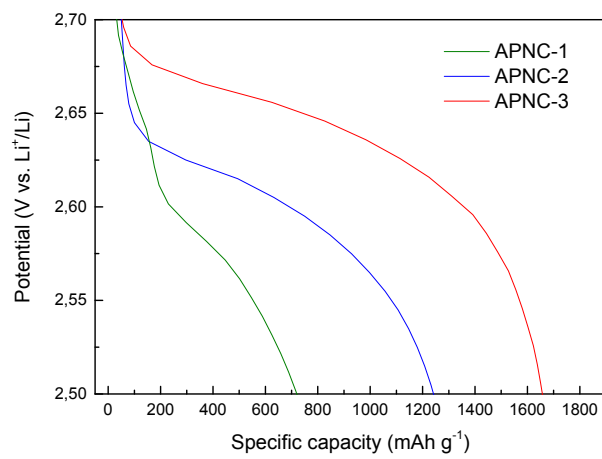


Figure S4. Overpotentials of APNCs at discharge.

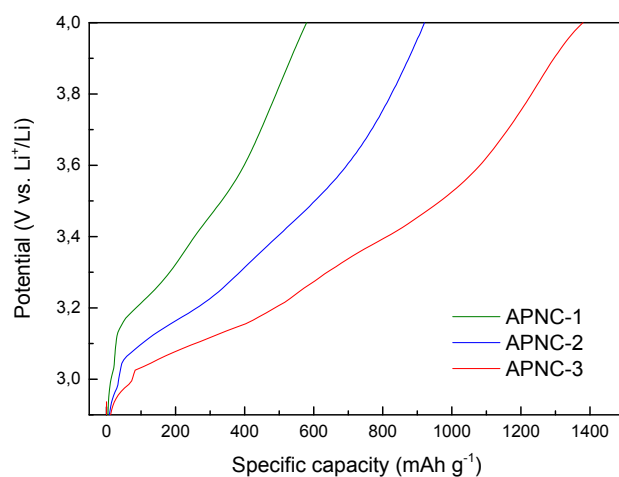


Figure S5. Overpotentials of APNCs at recharge.

Table S1. The detail amounts of nitrogen in APNCs.

Sample	Nitrogen content (wt. %)
APNC-1	4.86
APNC-2	4.95
APNC-3	4.87