Supplementary Information for:

Electrochemical behavior of carbon nanorod arrays having different graphene orientations and crystallinity

H. Orikasa, T. Akahane, M. Okada, Y. Tong, J. Ozaki and T. Kyotani

Anodic aluminum oxide template synthesis

The anodic aluminum oxide (AAO) template with a large number of nanochannels was prepared on an aluminum substrate by its anodic oxidation. Before the anodic oxidation, aluminum substrate (purity> 99.99%) was electropolished using 10 wt% HClO₄, 83% ethanol and 7% water mixed solvents at 20 V, 5°C for 10 min. The anodic oxidation was performed in 1.8 wt% oxalic acid at 80 V, 10 °C, and the resulting pores were widened by a chemical etching. The etching was carried out by immersing the anodically oxidized substrate in 5 wt% phosphoric acid at 30 °C for 30 min. The depth of the nanochannels was controlled within a range from 250 nm to 750 nm by changing the anodic oxidation time from 50 s to 90 s. The diameter of the resulting nanochannels is 70 nm, and the number of the nanorods per square centimeter is about 8×10^9 .

Electrochemical cell employed for cyclic voltammetry measurements

A schematic of the electrochemical cell employed for the cyclic voltammetry measurements is shown in Fig. S1. The cell is constituted of Pyrex glass having a dual structure. The outer vessel is a water jacket directly connected to a temperature-controlled bath to maintain the temperature of the electrolyte solution in the inner vessel at 25 °C. To fabricate the working electrode from the carbon film, only an array side of each carbon film was in contact with the electrolyte solution through a circular hole of a silicone gasket (inner diameter: 6 mm), and a current collector (a Pt plate) was attached to the backside of the carbon film. Thus the apparent surface area of the working electrode is always identical (0.28 mm²), regardless of the samples (the carbon films and a Pt plate).



Fig. S1 Electrochemical cell for cyclic voltammetry measurements

Cyclic voltammetric behavior of Ac-Ni

In addition to the redox peaks of ferri/ferro hexacyanide ions, a pair of undefined peaks was observed at the voltage around 0.7 V in Fig. 7e. These peaks can be ascribed to the redox reactions of nickel-containing compounds eluted from Ni metals, since these peaks were observed in another experiment using a pure Ni plate as a working electrode. Pinholes, such as broken nanorods would be the reason why such peaks were observed, but such broken ones were rarely found by the SEM observation. In addition, ΔE_p was far larger for CVD-Ni than the case with the Ni plate (for example, ΔE_p was 162 mV for CVD-Ni, and was 80 mV for the Ni plate at the sweeping rate of 100 mVs⁻¹.), suggesting that the surface of CVD-PVC is less active than the Ni plate. These facts indicate that the electrochemical reactions mainly occurred on the surface of the carbon covering the Ni core.