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## Defluorination-assisted nanotube-substitution reaction with ammonia gas for synthesis of nitrogen-doped single-walled carbon nanotubes

Nitrogen doping of single-walled carbon nanotubes (SWCNTs) plays a significant role as advanced functional materials. The methods of nitrogen doping are classified into two categories: Direct-synthesis doping and post-synthesis doping. Although a number of direct-synthesis nitrogen doping methods for SWCNTs have been studied, it is hard to control the number of nitrogen atoms and retain the crystallinity of nanotube framework. In contrast, little post-synthesis doping has been reported until now. In addition, these methods require high temperature (>1000 K), and the nitrogen contents of the resulting samples were low (<1.0 at.%). These are considered to be due to the low reactivity of SWCNT surface. Here, we report a new facile method to synthesize nitrogen doped SWCNTs by the reaction of fluorinated SWCNTs (F-SWCNTs) with ammonia gas. F-SWCNTs were prepared by fluorination of highly crystalline SWCNTs (hc-SWCNTs) synthesized by a direct current arc discharge, using a mixture of F2 (20%) and $N_2$ (80%) gases. The F-SWCNTs placed into a reactor tube reacted with flowing a mixture of $NH_3$ (1%) and $N_2$ (99%) gases at the temperature range of 573-873 K for 30 min. The resulting samples were characterized using X-ray photoelectron spectroscopy (XPS), high-resolution transmission electron microscopy (HRTEM), and Raman scattering spectroscopy. The XPS survey spectra of the samples after ammonia gas reaction revealed that nitrogen atoms were introduced into the SWCNTs at all reaction temperatures, and the maximum nitrogen content was estimated to be 3.0 at.% at 673 K. The XPS spectra of $N_{1s}$ region showed the SWCNTs had pyridinic, pyrrolic, and graphitic nitrogen atoms. Structural and electrochemical properties in this presentation will be discussed in detail.

### Biography

Yoshinori Sato completed his Bachelor and Master degrees in Materials Science and Engineering at Yamagata University, Japan, in 1994 and 1996, respectively, and PhD in Graduate School of Engineering at Tohoku University, Japan, in 2002. In 2004, he joined the Graduate School of Environmental Studies, Tohoku University, as an Assistant Professor, and in 2010 became an Associate Professor. He joined the Institute for Biomedical Sciences, Interdisciplinary Cluster for Cutting Edge Research, Shinshu University, Japan, as a specially approved Visiting Professor, in 2014. His current research interests include “Defect engineering of carbon nanotubes”. He is an Editorial Board Member of *Scientific Reports* (Nature Publishing Groups). He is a regular member of the American Chemical Society (ACS), the Materials Research Society (MRS), and the Electrochemical Society (ECS).

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