Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Enhancement of ORR Catalytic Activity by Multiple Hetero-atom Doped Carbon Materials

*Dae-wook Kim,[a] Oi Lun Li,[b] and Nagahiro Saito[abc]**

[a]Department of Materials, Physics and Energy Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

[b]Green Mobility Collaborative Research Center, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

[c]EcoTopia Science Institute, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

E-mail: hiro@rd.numse.nagoya-u.ac.jp

Telephone/fax: +81-52-789-3177

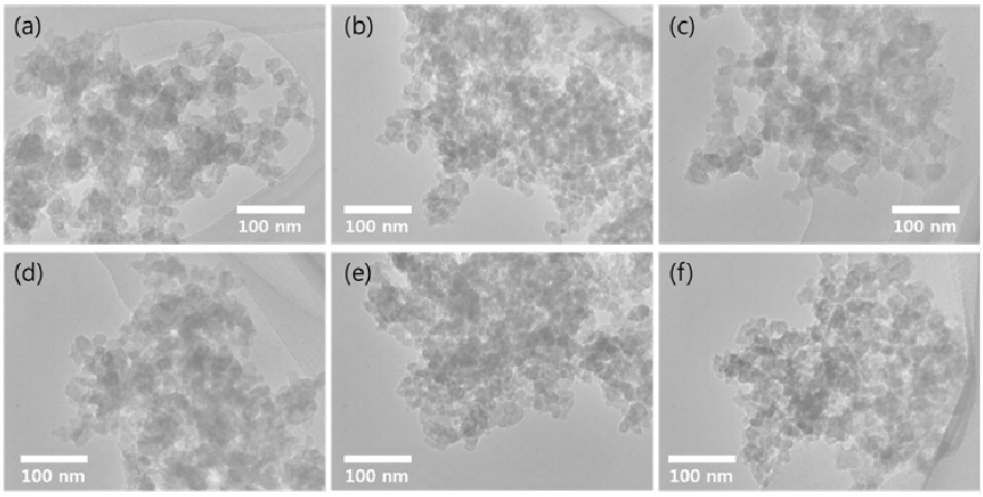

Fig. S1. TEM images of synthesized carbon nanoparticles (a) CNS, (b) NCNS, (c) BCNS, (d) PCNS, (e) BNCNS, (f) PNCNS. ; All synthesized particles have spherical morphology with uniform size (20~30 nm) and it became an agglomeration structure.

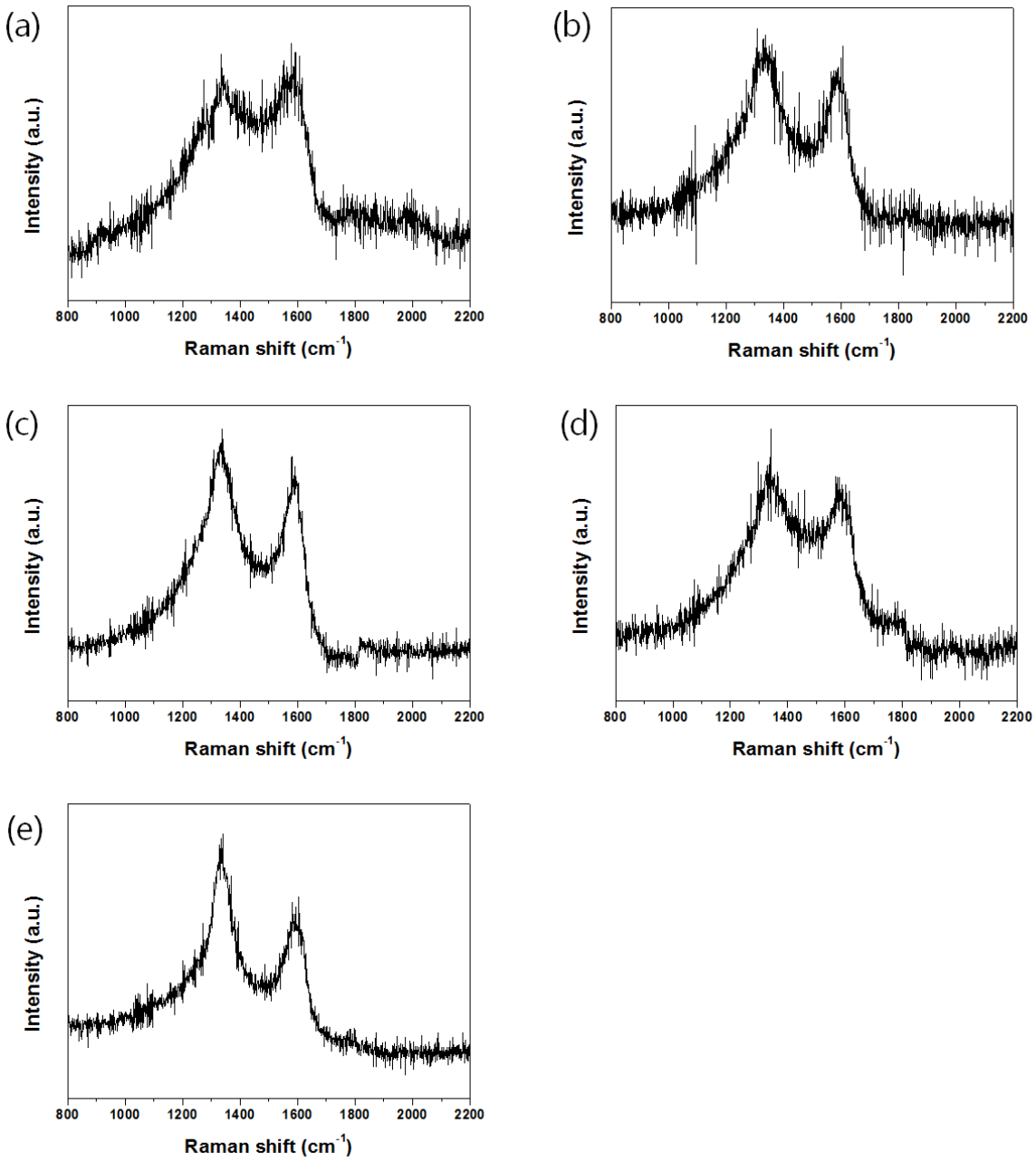

Fig. S2. Raman spectra of hetero-atom doped carbon nanoparticles.
(a) CNS, (b) BCNS, (c) PCNS, (d) BNCNS, (e) PNCNS.

Table S1. Chemical compositions and doping concentrations of the sample obtainded from the XPS analysis.

	Chemical compositions (at%)					Doping concentrations			
	C	N	O	P	B	O/C	N/C	P/C	B/C
NCNS	93.4	3.0	3.6	-		3.85	3.21	-	-
BCNS	95.3	-	3.3	-	1.4	3.46	-	-	1.47
PCNS	95.5	-	3.9	0.6	-	4.08	-	0.63	-
BNCNS	90	4.0	3.7	-	1.9	4.11	4.44	-	2.11
PNCNS	87.3	3.8	7.5	1.4	-	8.59	4.35	1.60	-

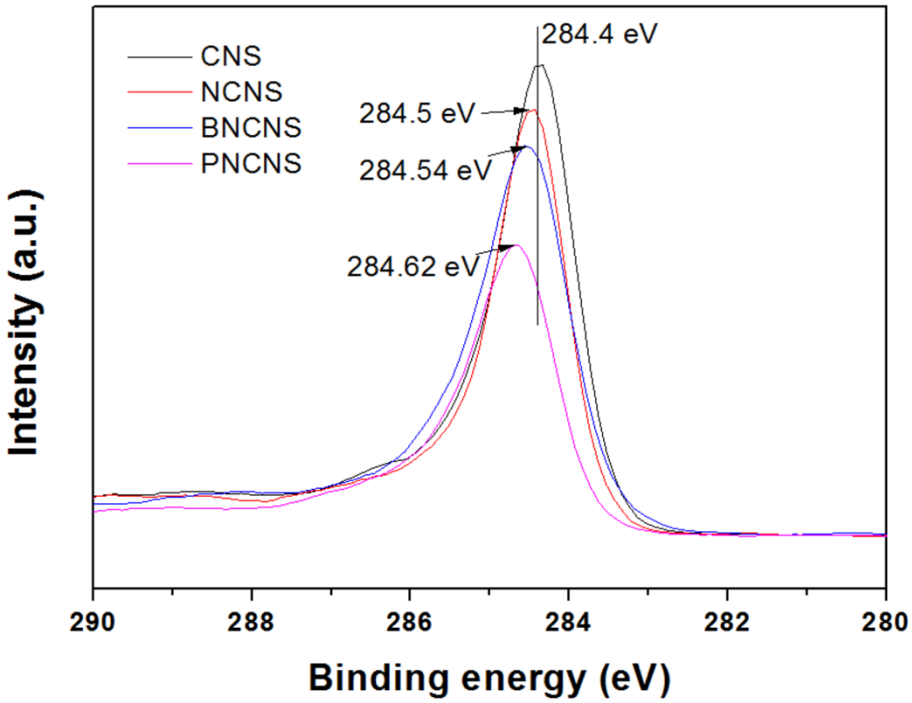

Fig. S3. C1s spectra of hetero-atom doped carbon nanoparticles

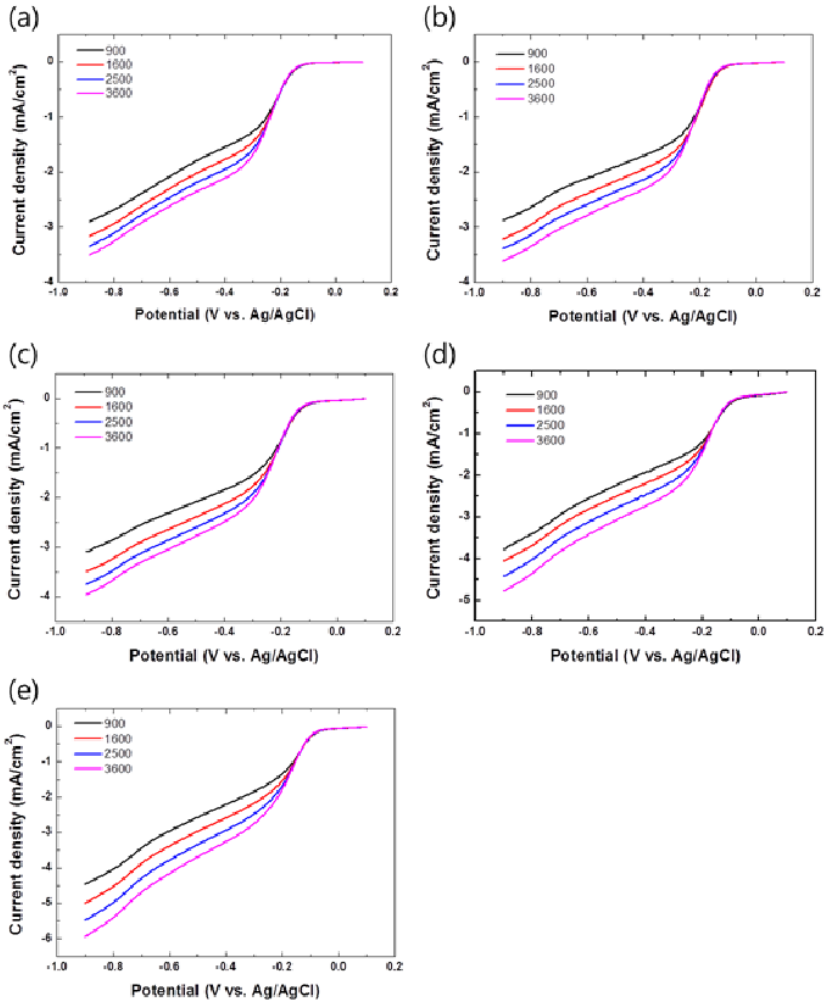

Fig. S4. Linear sweep voltammetry of hetero-atom doped carbons at various rotation speed (a) BCNS, (b) PCNS, (c) NCNS, (d) BNCNS, (e) PNCNS.