

Supplementary information

A double core-shell modification of bulk TiO₂ microspheres into porous N-doped-graphene carbon nanoflakes/N-doped TiO₂ microspheres for lithium-ion battery anodes

Balasubramaniyan Rajagopalan, Eun-Suok Oh, Won Mook Choi, and Jin Suk Chung*

School of Chemical Engineering, University of Ulsan, Namgu, Daehakro 93, Ulsan 680-749, Republic of Korea.

*Corresponding author Tel: +82 52 259 2249 Fax: +82 52 259 1689

Description of the SEM-EDAX, FE-SEM, XRD, TGA, XPS, BET, and Raman analysis of the TiO₂ microsphere and surface modified TiO₂ microsphere nanocomposites.

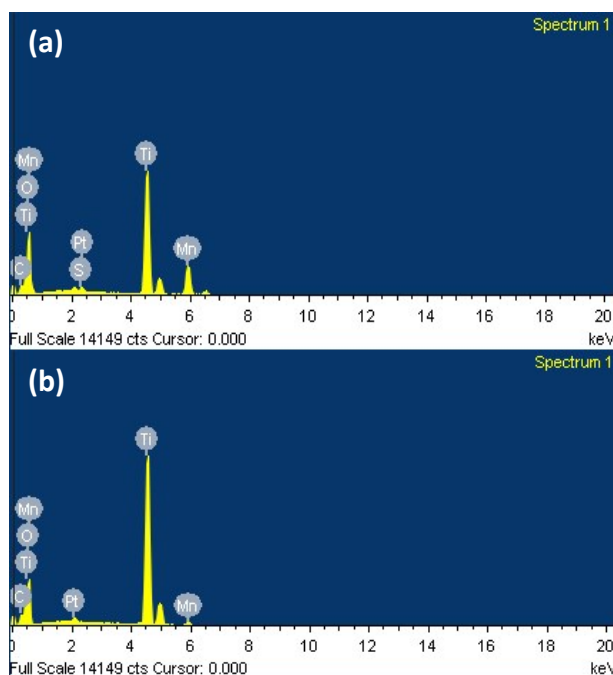


Fig. S1 SEM-EDAX analysis of the (a) Mn₃O₄/TiO₂ and (b) PANI/TiO₂ nanocomposites.

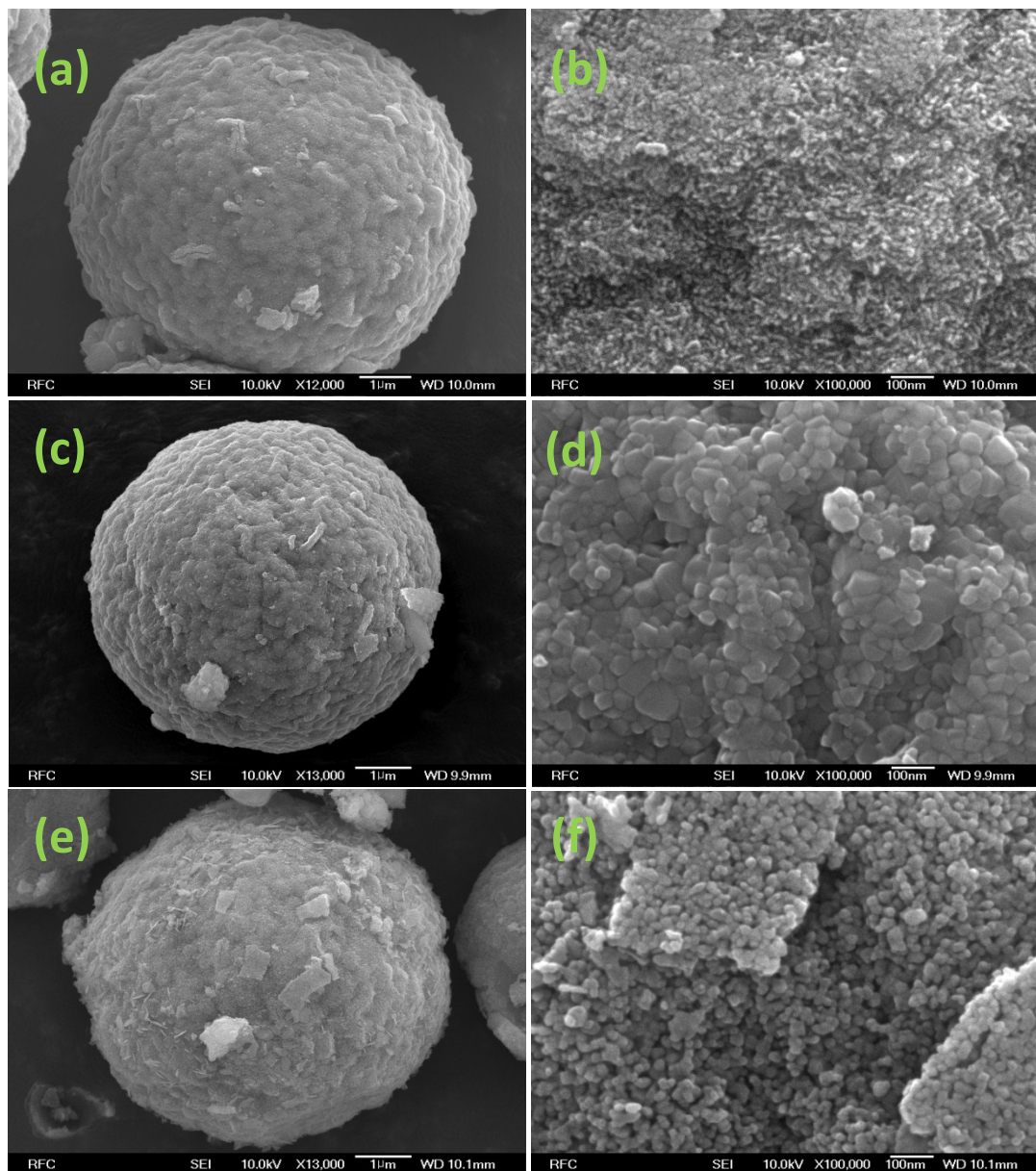


Fig. S2 FE-SEM images of (a, b) Carbon/TiO₂, (c, d) TiO₂, and (e, f) NC/NTiO₂ after the calcination under the air atmosphere.

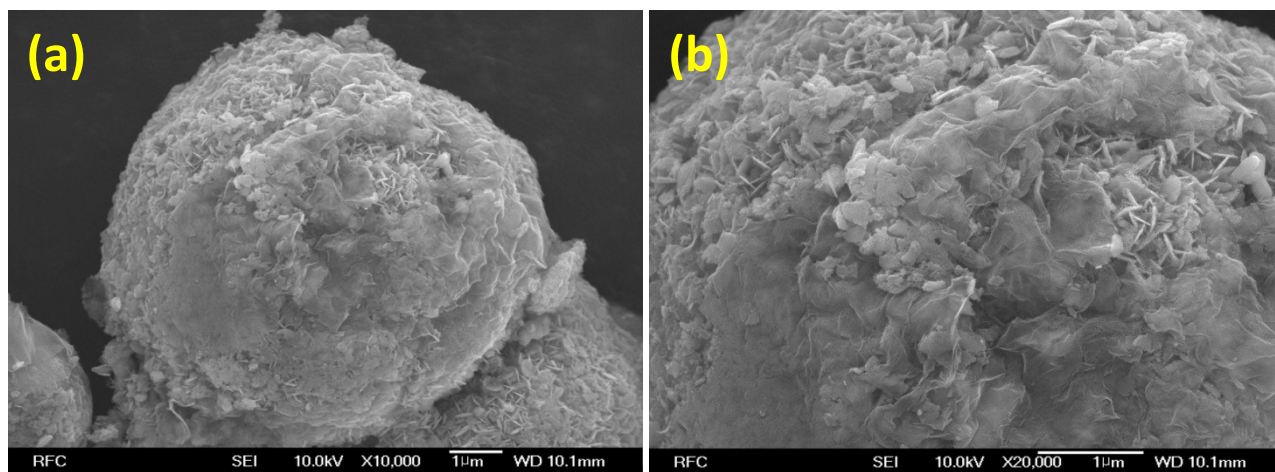


Fig. S3 (a) RTNG-NC/NTiO₂ nanocomposite, which is partially covered by NG sheets, and (b) higher magnification of (a).

Table S1 The calculation of particle diameter from XRD by using scherrer equation.

Nanocomposites	Pos. [$^{\circ}2\theta$.]	Theta	FWHM Left [$^{\circ}2\theta$.]	FWHM in radian	theta in radian	COS Theta in radian	D (nm)
TiO ₂	25.3	12.65	0.186	0.003245	0.220672	0.975751	47.66921
Carbon/TiO ₂	25.27	12.635	0.889	0.015508	0.220411	0.975808	9.97295
NC/NTiO ₂	25.3	12.65	0.772	0.013467	0.220672	0.975751	11.48507
TNG-NC/NTiO ₂	25.29	12.645	0.51	0.008897	0.220585	0.97577	17.3849
RTNG-NC/NTiO ₂	25.26	12.63	0.521	0.009089	0.220323	0.975827	17.01685

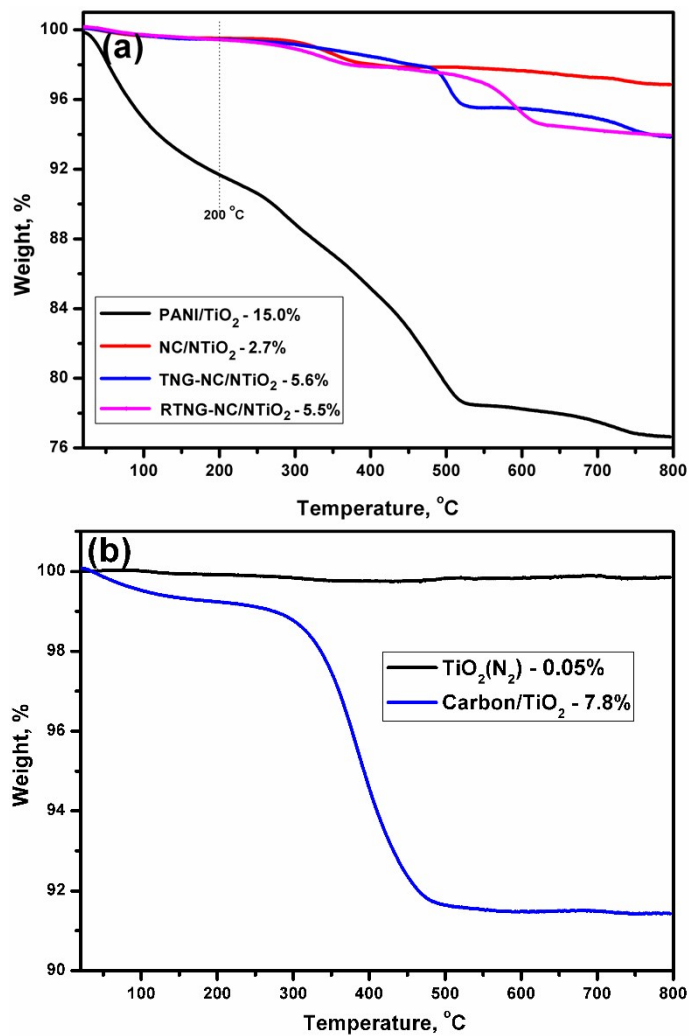


Fig. S4 TGA of the (a) surface modified TiO₂ nanocomposites. (b) TGA of the TiO₂ (calcination of solvothermally reacted TiO₂ in N₂ atmosphere) and carbon/TiO₂ (calcination of titanium glycolate) nanocomposites.

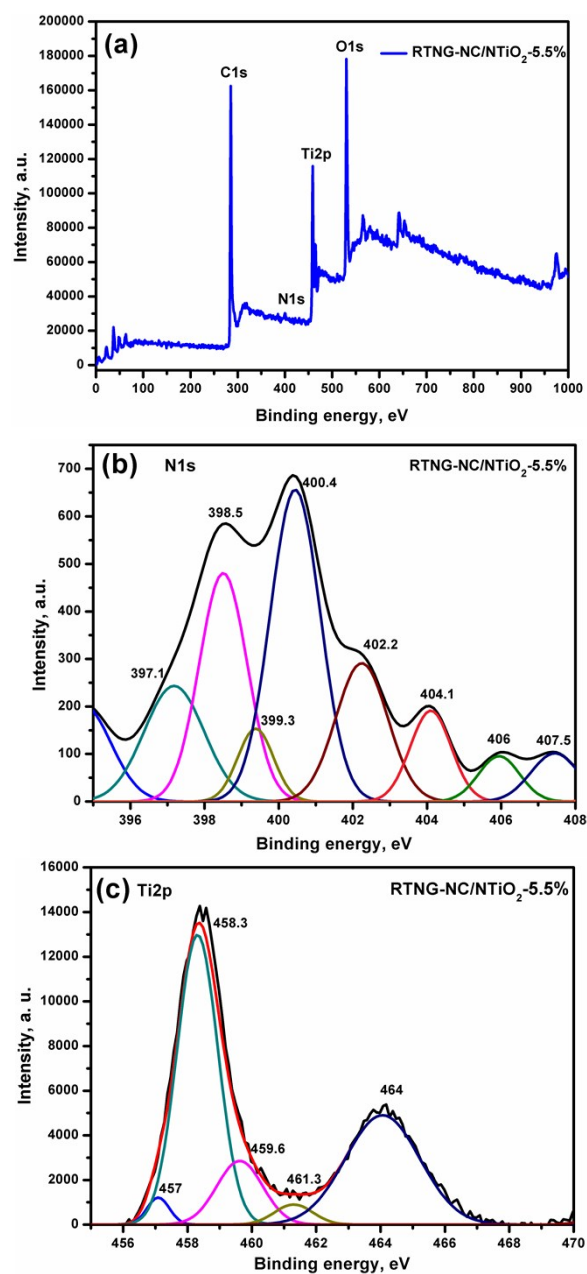


Fig. S5 XPS (a) survey scan spectra, (b) N1 spectra, and (c) Ti2p analysis of the RTNG-NC/NTiO₂ nanocomposite.

Table S2 The surface areas and pore volumes of the TiO₂ and its nanocomposites.

Nanocomposites	Specific surface area (m ² g ⁻¹)	Pore volume (cm ³ g ⁻¹)
TiO ₂	8.7	0.04
Carbon/TiO ₂ -7.8%	82.3	0.053
NC/NTiO ₂ -2.7%	45.6	0.110
TNG-NC/NTiO ₂ -5.6%	34.7	0.105
RTNG-NC/NTiO ₂ -5.6%	59.1	0.137

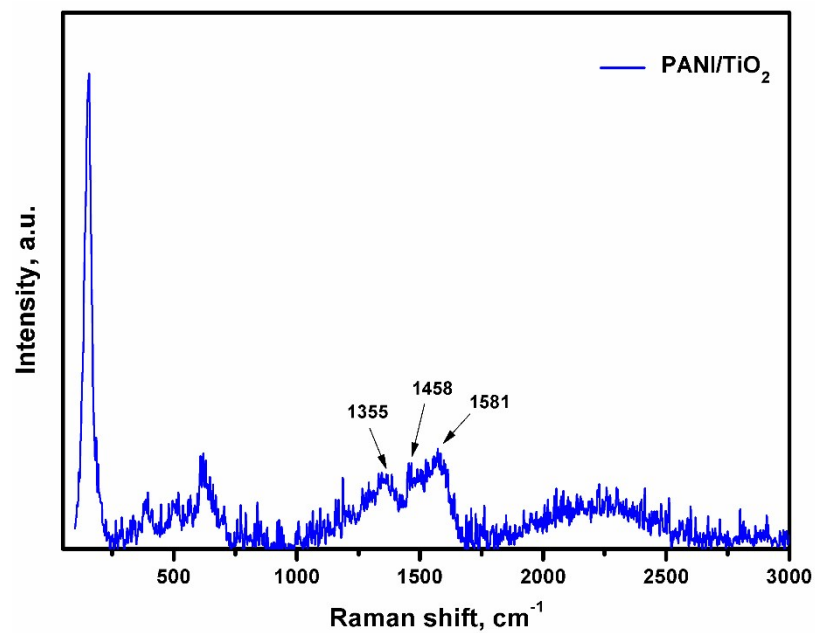


Fig. S6 Raman spectroscopy of the PANI/TiO₂ nanocomposite.

As shown in Figure S6, the formation of peaks at 1355, 1458, 1581 cm⁻¹ are clearly indicating the presence of PANI on the PANI/TiO₂ nanocomposites (H. Wang, Q. Hao, X. Yang, L. Lu, and X. Wang, *ACS Appl. Mater. Interfaces*, 2010, **2**, 821-828).