Supplementary Material

UV and Visible Light-Driven Production of Hydroxyl Radicals by Reduced Forms of N, F, and P Codoped Titanium Dioxide

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HRTEM analysis

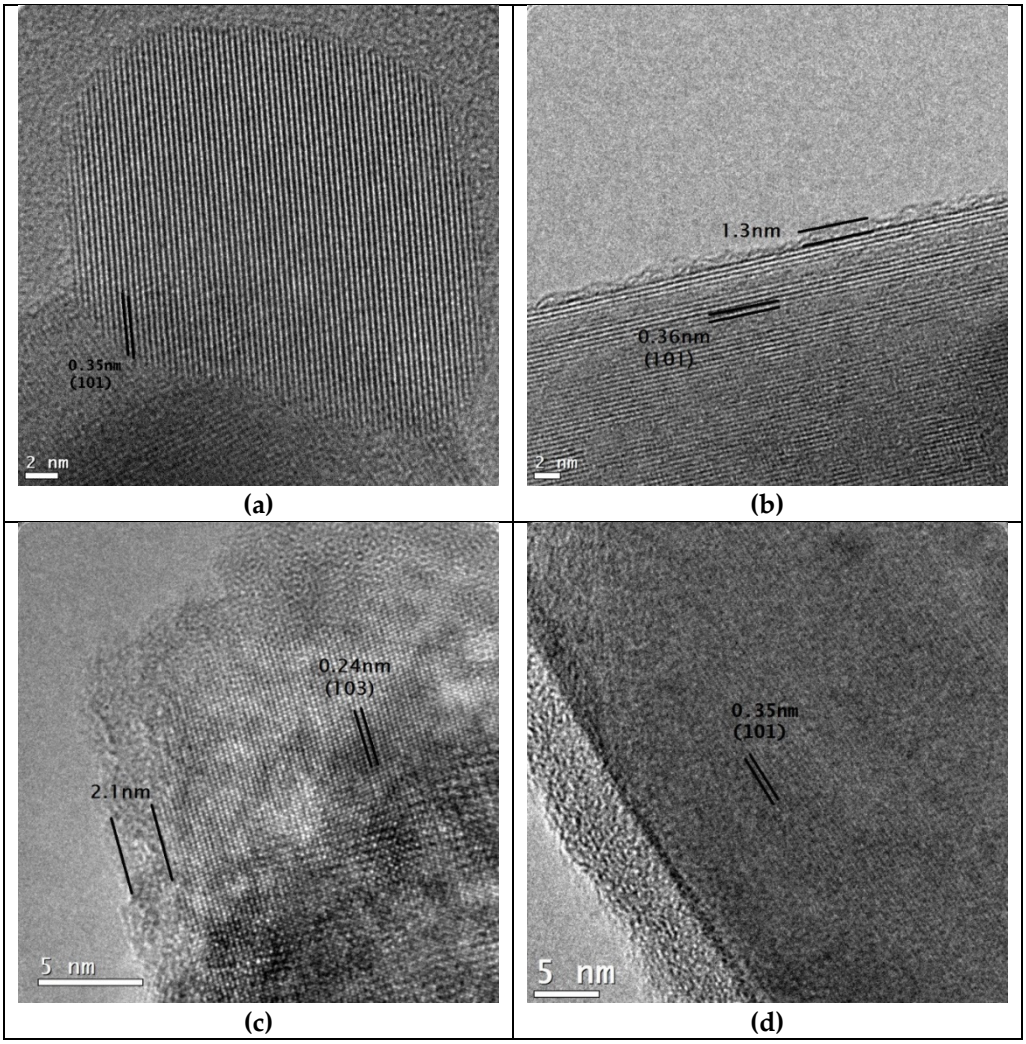

Figure S1a. HRTEM images of N, and F codoped TiO_2 nanocrystals (a) NF-TiO_2 before reduction, (b) NF-$TiO_2^{red\ 30}$ (1.3 nm of the amorphous layer), (c) NF-$TiO_2^{red\ 50}$ (2.1 nm of the amorphous layer) and (d) NF-$TiO_2^{red\ 70}$ (6.0 nm of the amorphous layer)

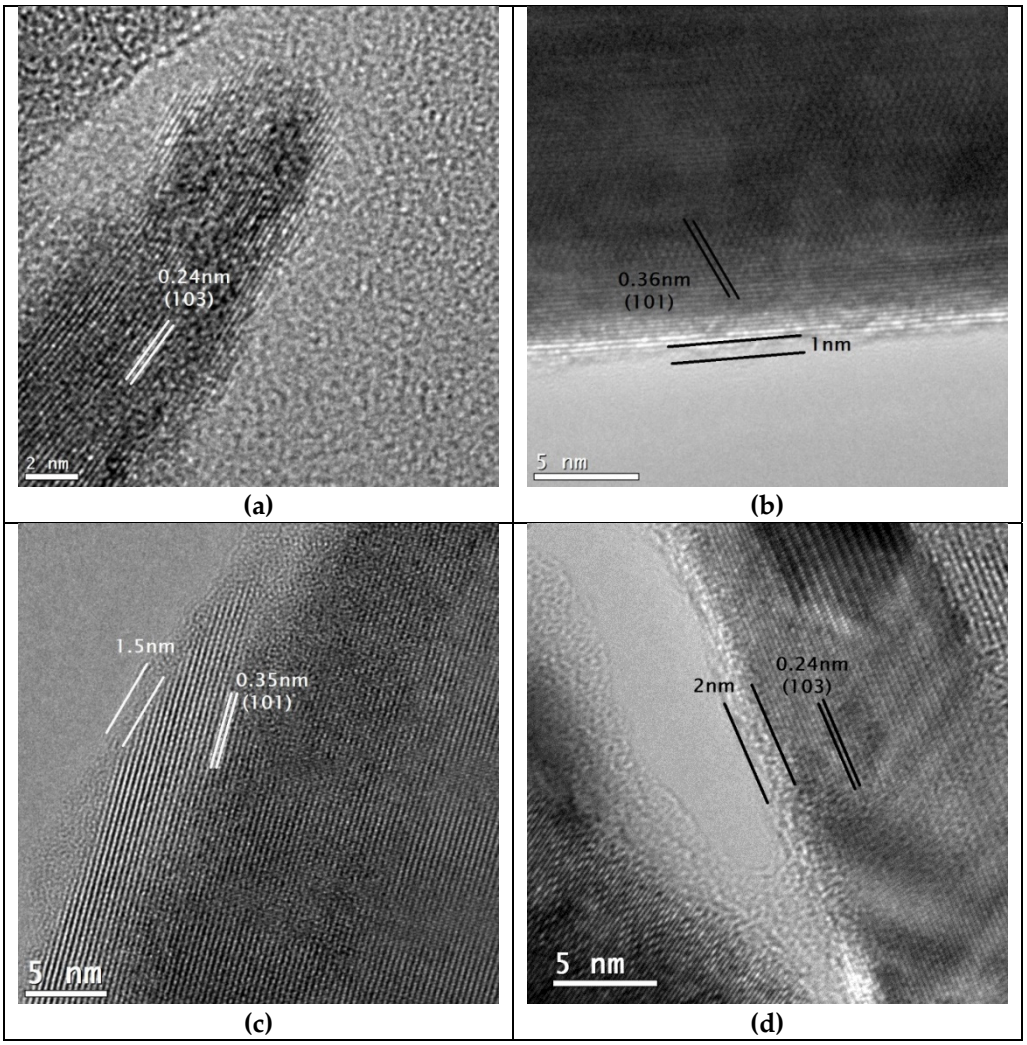

Figure S1b. HRTEM images of N, F, and P codoped TiO_2 nanocrystals (a) NFP-TiO_2 before reduction, (b) NFP-$TiO_2^{red\ 30}$ (1.0 nm of the amorphous layer), (c) NFP-$TiO_2^{red\ 50}$ (1.5 nm of the amorphous layer) and (d) NFP-$TiO_2^{red\ 70}$ (2.0 nm of the amorphous layer)

EDXRF Analysis

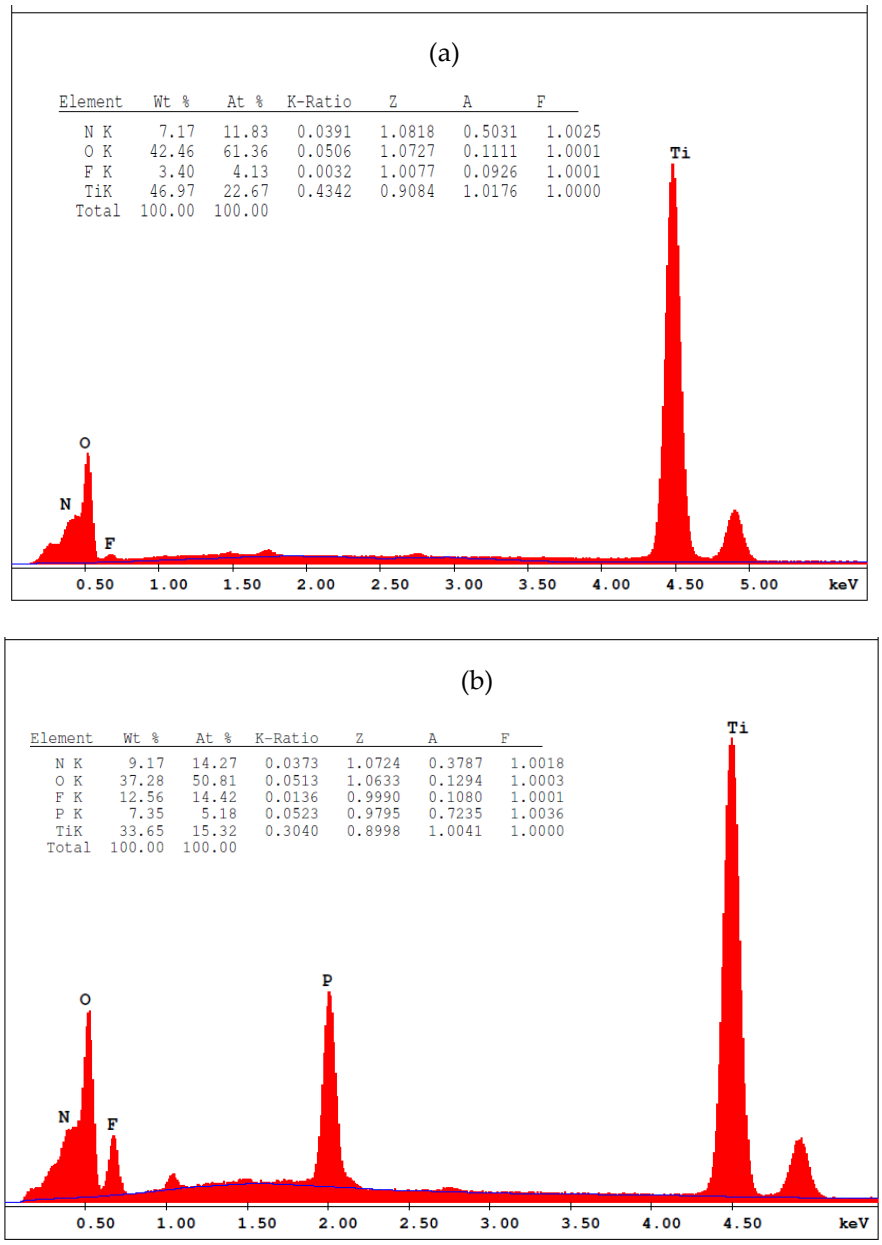

Figure S2. EDXRF spectrum of (a) N, and F codoped TiO_2 (NF-TiO_2) and (b) N, F, and P codoped TiO_2 (NFP-TiO_2)

UV-Visible spectroscopy

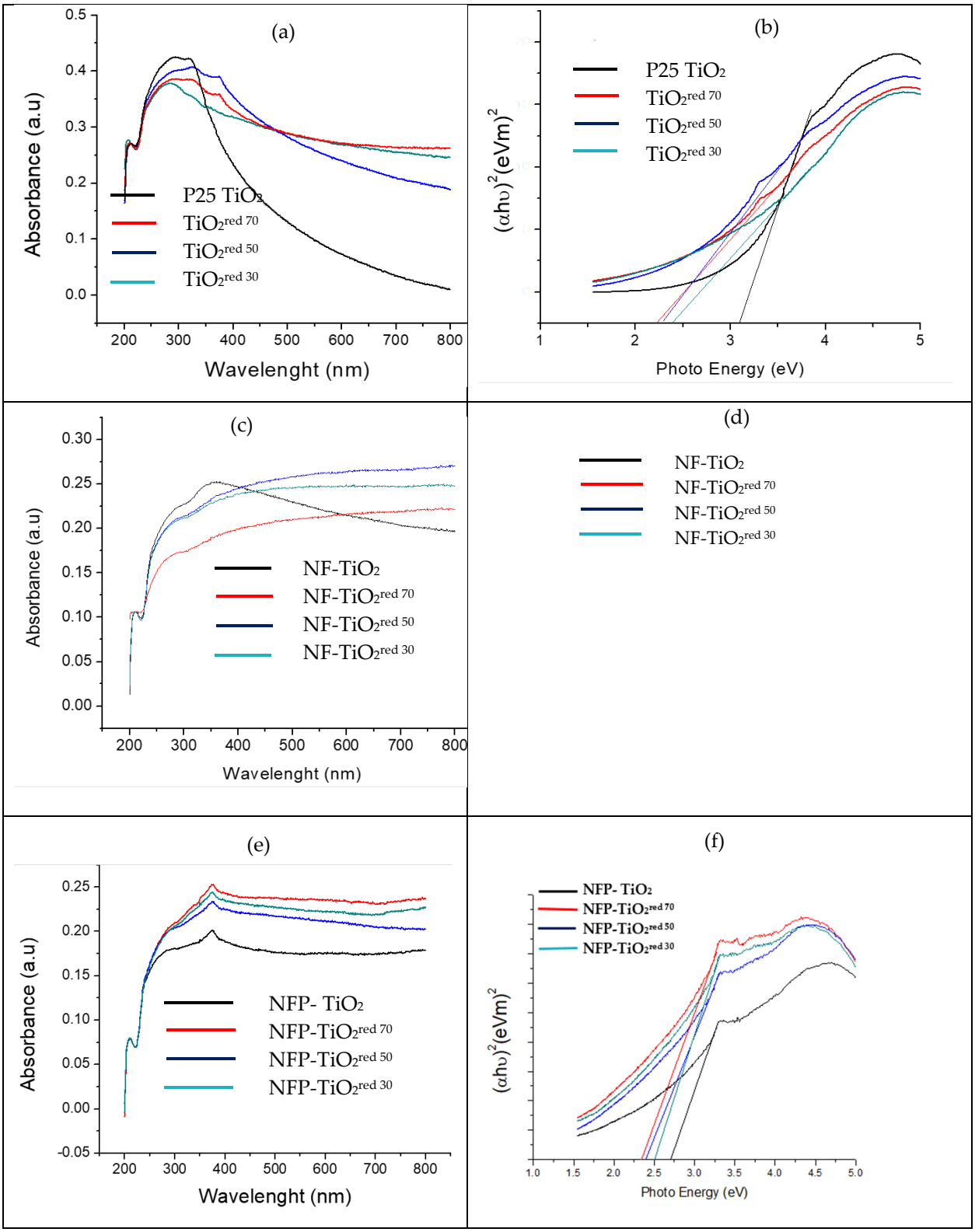

Figure 3. UV-Visible diffuse reflectance spectra of (a) P25 TiO_2 series, (c) NF-TiO_2 series, and (e) NFP-TiO_2 series. The Kubelka-Munk plot for band energy calculation for (b) P25 TiO_2 series, (d) NF-TiO_2 series, and (f) NFP-TiO_2 series.

Raman Spectroscopy

Table S1a. Raman band position of P25 TiO_2 and reduced P25 TiO_2 (TiO_2^{red})

P25 TiO_2 (cm^{-1})	$TiO_2^{red\ 70}$ (cm^{-1})	$TiO_2^{red\ 50}$ (cm^{-1})	$TiO_2^{red\ 30}$ (cm^{-1})	Band
143	146	143	145	Eg1
396	394	395	397	Bg1
516	511	511	521	Ag1
637	634	634	636	Eg3

Table S1b. Raman band position of NF-TiO_2 and reduced NF-TiO_2^{red}

NF-TiO_2 (cm^{-1})	NF-$TiO_2^{red\ 70}$ (cm^{-1})	NF-$TiO_2^{red\ 50}$ (cm^{-1})	NF-$TiO_2^{red\ 30}$ (cm^{-1})	Band
142	144	145	144	Eg_1
393	393	392	393	Bg_1
512	511	512	511	Ag_1
635	634	633	633	Eg_3

Table S1c. Raman band position of NFP- TiO_2 and reduced NFP-TiO_2^{red}

NFP-TiO_2 (cm^{-1})	NFP-$TiO_2^{red\ 70}$ (cm^{-1})	NFP-$TiO_2^{red\ 50}$ (cm^{-1})	NFP-$TiO_2^{red\ 30}$ (cm^{-1})	Band
143	148	147	149	Eg_1
393	390	390	391	Bg_1
511	506	509	507	Ag_1
636	630	634	633	Eg_3

Production of hydroxyl radicals by reduced doped TiO_2

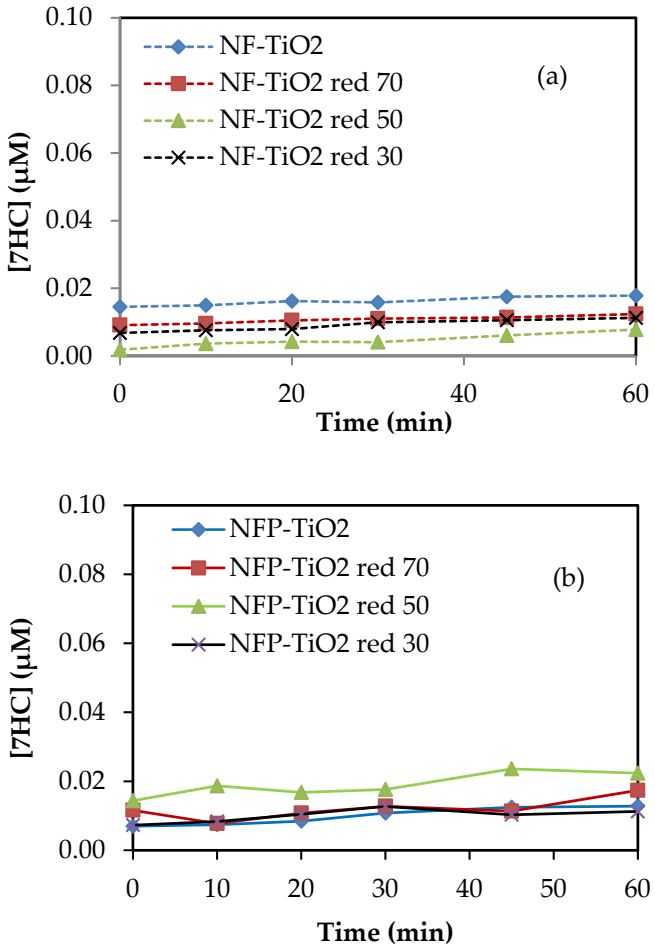

Figure S4. The production of 7HC at 350 nm by (a) reduced NF-TiO_2 and (b) NFP-TiO_2 photocatalyst

Calibration curve for the measurement of 7-Hydroxycoumarin

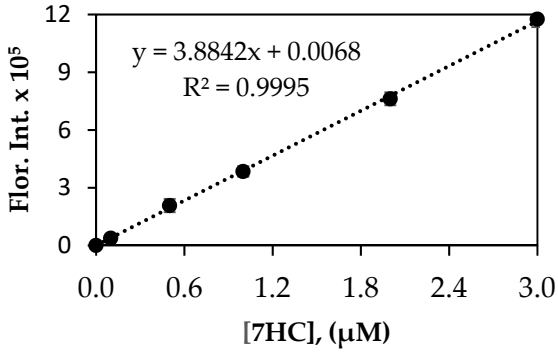

Figure S5. Spectrofluorometric calibration curve for measuring of 7HC. The data is reproducible within 5% standard deviation based on triplicate runs.