Supporting Information

Photochemical Conversion of Nitrate to Ammonium Ion by a Newly Developed Photo-Reductive Titanium Dioxide Catalyst: Implications on Nitrogen Recovery

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Table S1. Composition of synthetic groundwater used in this study.

Chemical composition*	**Concentration (mg/L)**
Nitrate	100
Chloride	13
Bicarbonate	38
Sulfate	33
Silica	37
Sodium	14
Potassium	4
Calcium	24
Magnesium	6
TOC	4.5
pH	8.0

* The synthetic groundwater chemical composition was based on reported values in literature (Ottofuelling, S.; Von Der Kammer, F.; Hofmann, T. Commercial Titanium Dioxide Nanoparticles in Both Natural and Synthetic Water: Comprehensive Multidimensional Testing and Prediction of Aggregation Behavior. *Environ. Sci. Technol.* **2011**, 45 (23), 10045–10052.)

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Table S2. Nitrate removal efficiency by photo-reduction TiO_2 in DI water and synthetic groundwater matrix.*

Water Matrix	Nitrate Removal Efficiency (%)	Selectivity of ammonium ion (%)	Formation of nitrite (%)
DI Water	95	70	Not detected
Synthetic Groundwater	99	60	Not detected

*Nitrate removal, nitrite formation and ammonia selectivity data represent samples collected at 5 hours of the photocatalytic reaction.

Text S1. **Ammonia Measurements**

Phenol Reagent is prepared by adding 1.1 mL of liquified phenol to 9.9 mL of 200 proof ethanol in a tube. Sodium Nitroprusside is prepared by transferring 500 mg of sodium nitroprusside to a 100 mL flask and transferring the solution to a stock bottle. Alkaline Citrate is prepared by adding 10 g of sodium citrate anhydrous to a 50 mL volumetric flask, followed by 500 mg of sodium hydroxide. 10 mL of this solution is added to 2.5 mL of sodium hypochlorite to prepare a solution of hypochlorous alkaline citrate. 85 µL of sample is added to 765 µL of DI water, followed by 34 µL of phenol solution, 34 µL of sodium nitroprusside and 85 µL of hypochlorous alkaline citrate solution. The sample is kept for 1 hour and read at 640 nm.

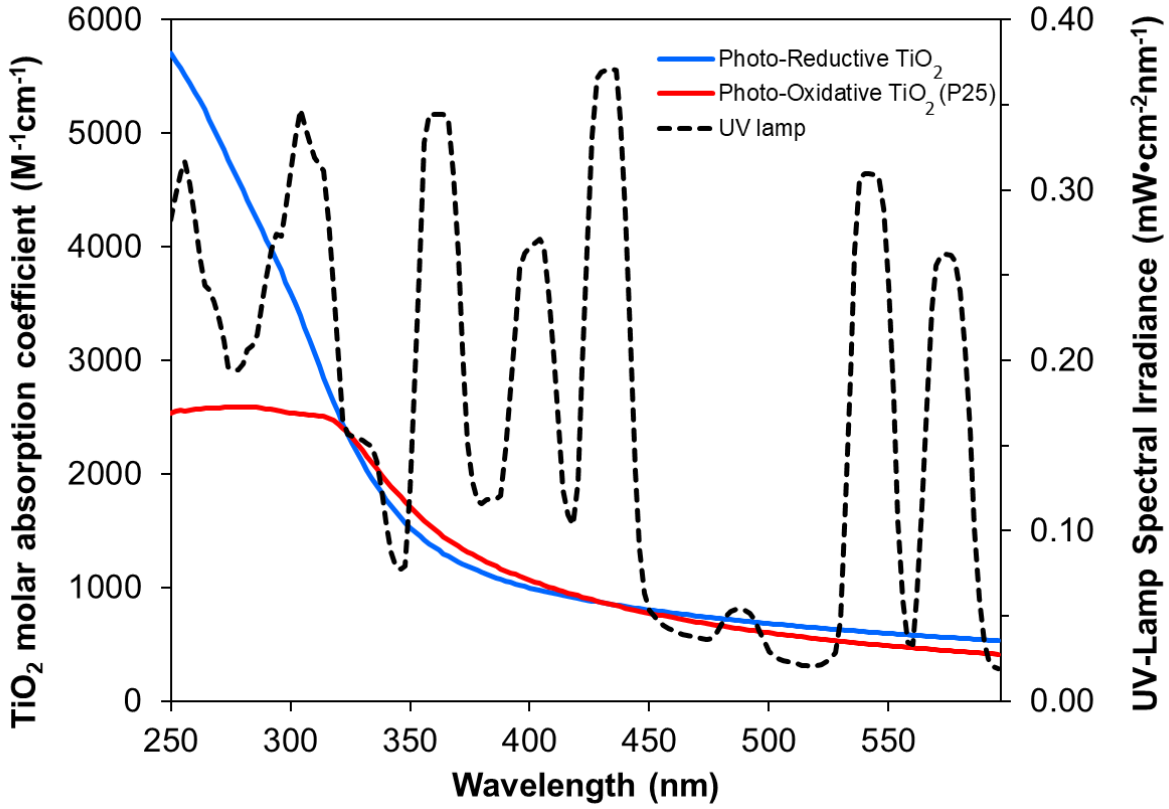

Figure S1. UV-Vis for DEG-doped TiO_2 nanoparticles synthesized at 230ºC and for industrial TiO_2 catalyst P25 both at 50 mg/L and irradiance spectra output for the medium-pressure UV lamp used to conduct all experiments.

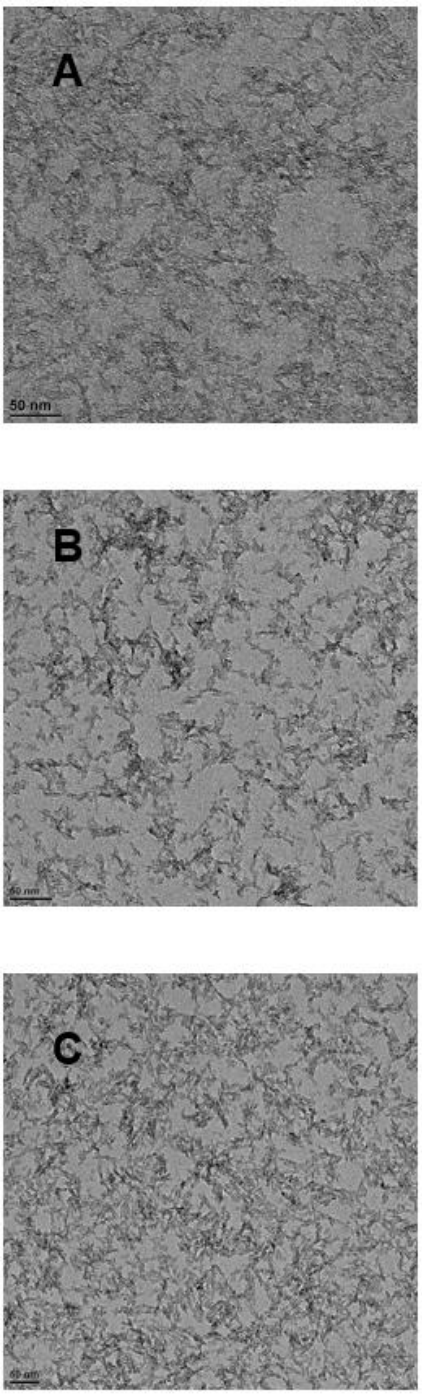

Figure S2. Transmission Electron Microscopy micrograph of synthesized photo-reductive TiO_2 nanocrystals with different heating time for hydrolysis at 230^{o}C. (A) 3 hours; (B) 6 hours; (C) 9 hours.

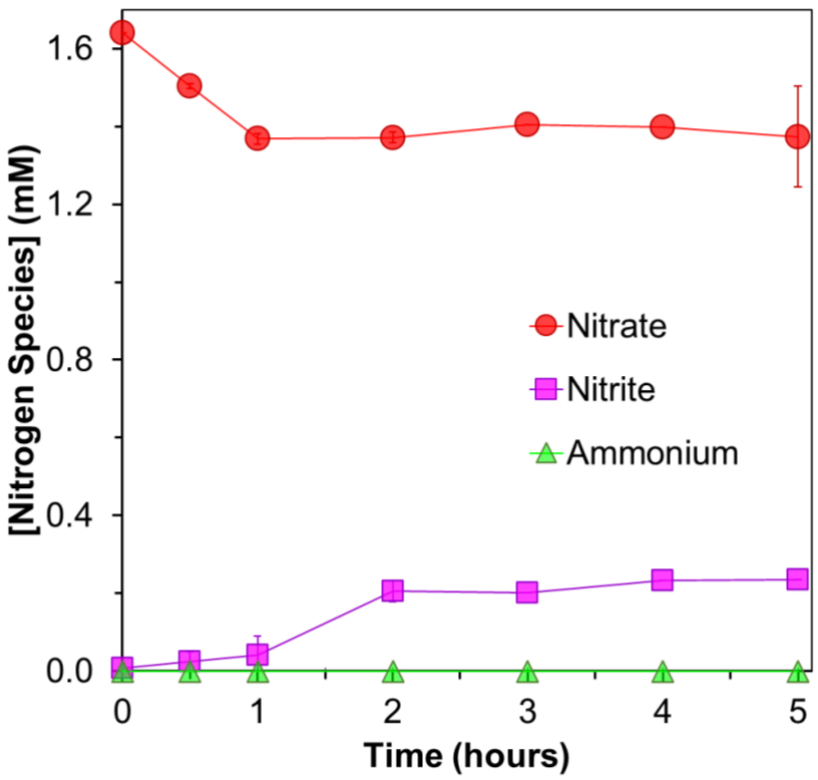

Figure S3. Nitrogen speciation profile during photochemical nitrate reactions in the presence of photo-oxidative P25 Degussa TiO_2 catalyst. [Nitrate] = 1.6 mM, [TiO_2] = 50 mg/L. pH = 7.

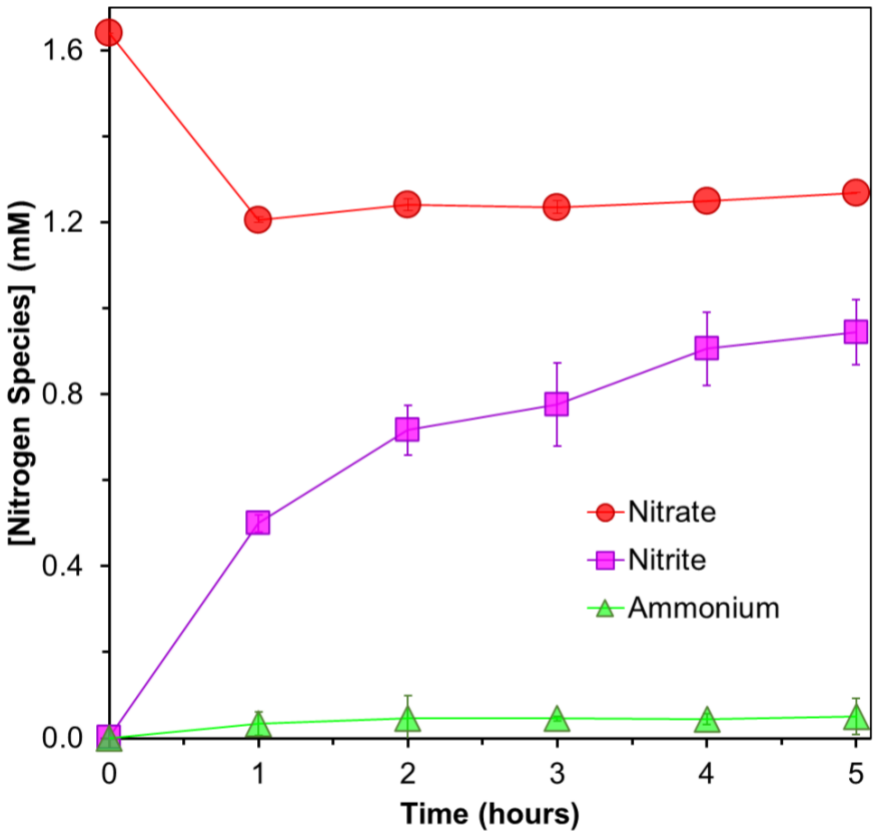

Figure S4. Nitrogen speciation profile for nitrate solution in the catalyst control experiment in the absence of photocatalyst and only with UV irradiation. [Nitrate] = 1.6 mM, [TiO_2] = 50 mg/L, pH = 7.

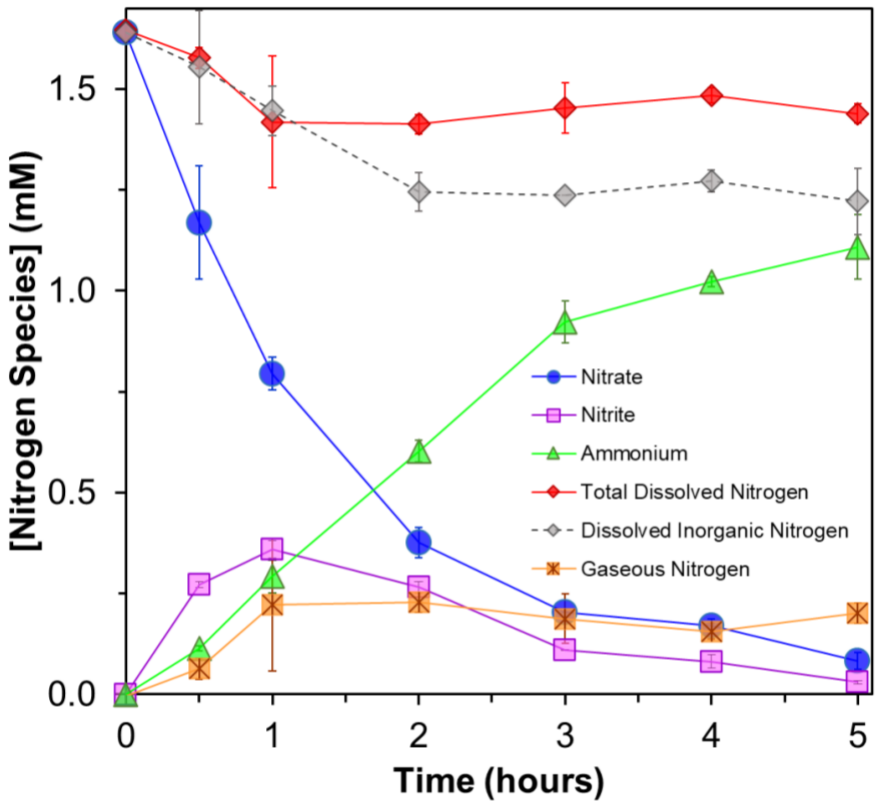

Figure S5. Nitrogen speciation profile for nitrate solution during photochemical reactions in the presence of synthesized DEG-TiO_2 catalyst. Synthesis temperature = 230°C, [Nitrate] = 1.6 mM, [TiO_2] = 50 mg/L, pH = 7.