

Supporting Information

**Optical and Electrochemical Tuning of Hydrothermally Synthesized
Nitrogen-Doped Carbon Dots**

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Supporting Information

S.T1 Table of doping ratios employed for NCD syntheses

S1. TEM micrographs of undialyzed vs dialyzed undoped CDs

S2. Additional TEM micrographs of dialyzed NCD particles

S3. XPS survey spectra as well as high resolution C 1 s spectra for all synthesized CD samples

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S8. Full NCD cyclic voltammograms and background subtracted negative scan

S9. Correlation between peak current and scan rate $^{1/2}$

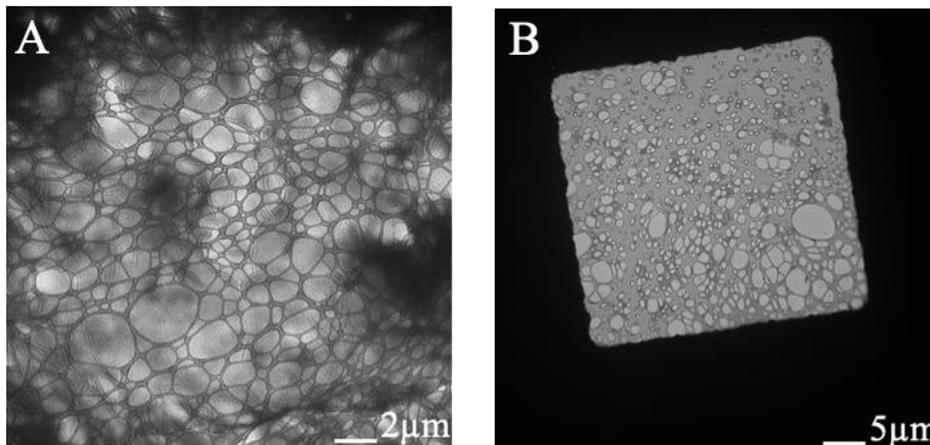
S10. Scan rate dependence of detected peak currents for NCD oxidations

S.T1

Table denoting the amount of urea added to doped batches of CDs relative to the amount of citrate. As the ratio increases, the amount of urea present in the synthesis decreases.

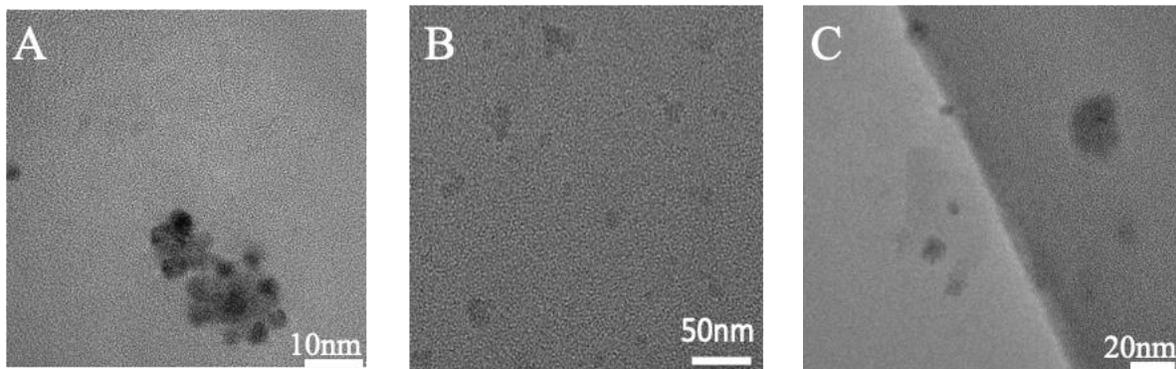
	Mmol of Urea	Mmol of Citrate
CD	0	10
1:2 NCD	5	10
1:10 NCD	1	10
1:25 NCD	0.4	10

S1. TEM micrographs of undialyzed vs dialyzed starting materials



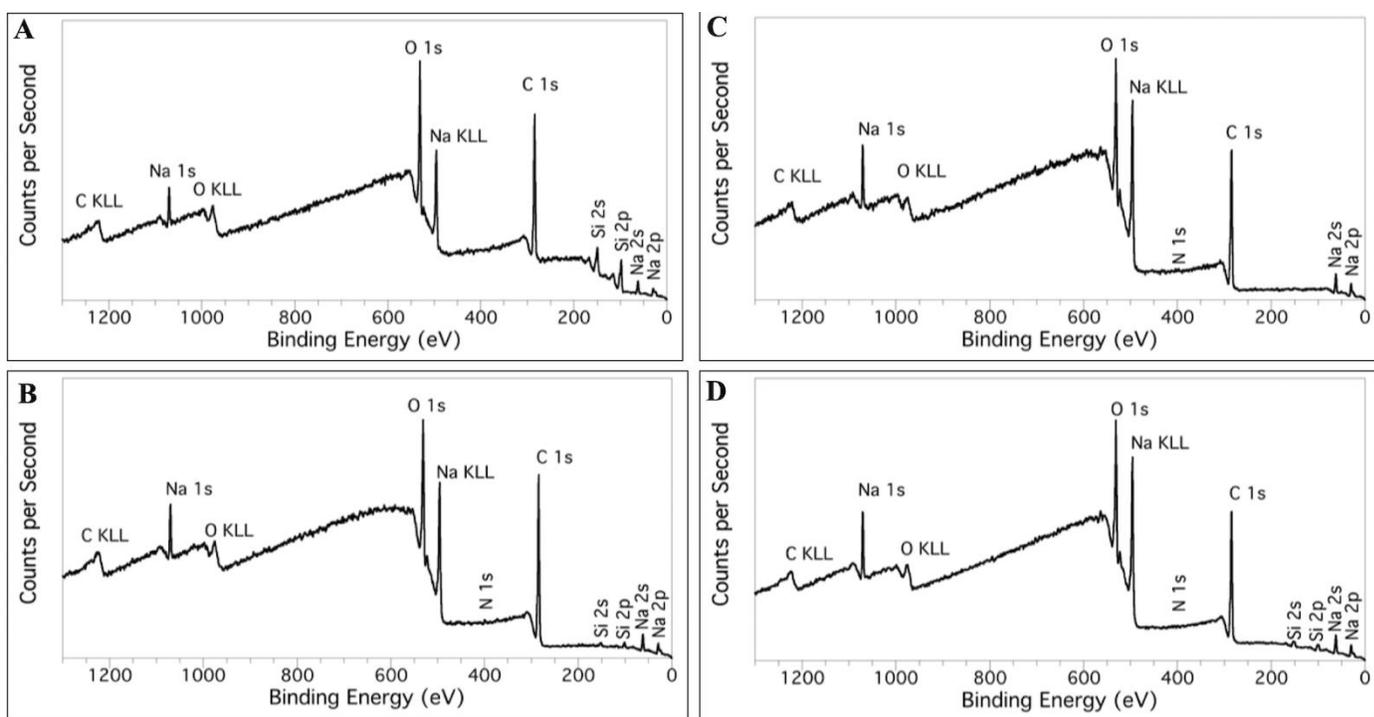
TEM micrographs of grids prepared from A) undialyzed and B) dialyzed CD solutions. The grids prepared from undialyzed were saturated with amorphous carbonaceous material and no carbon dots could be visualized. Purification via dialysis was effective in cleaning the product and resulting prepared TEM grids.

S2. Additional TEM micrographs of NCDs

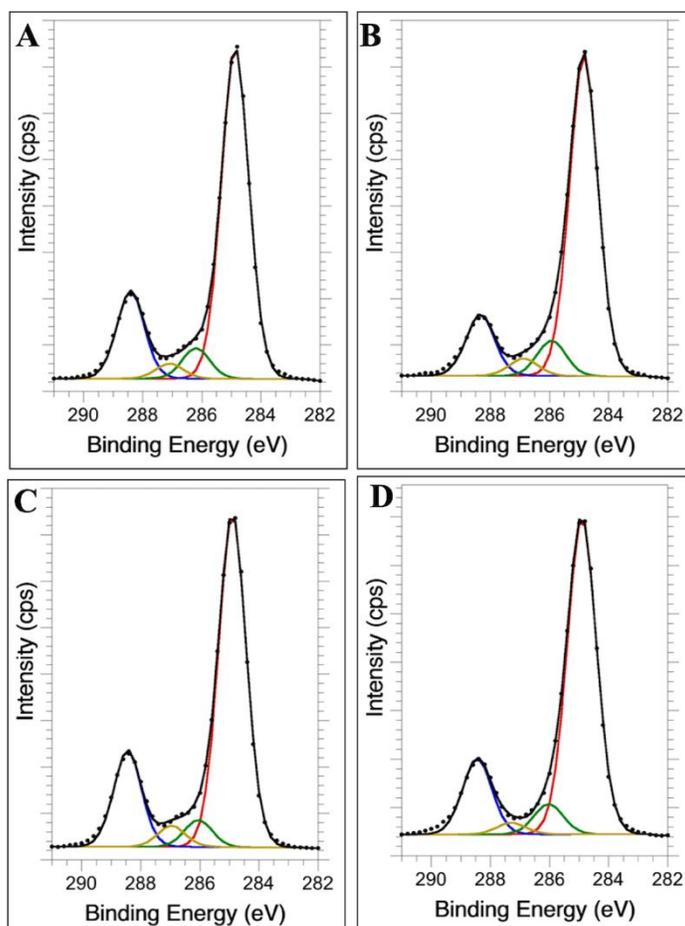


Additional TEM images of NCDs synthesized under A) 1:2 NCD, B) 1:10 NCD, and C) 1:25 NCD. Using the described synthetic method presented in this work, particle formation occurs regardless of the employed doping ratio thanks to favorable reaction conditions held by the citrate buffer.

S3. XPS survey spectra as well as high resolution C(1s) spectra for all synthesized CD samples

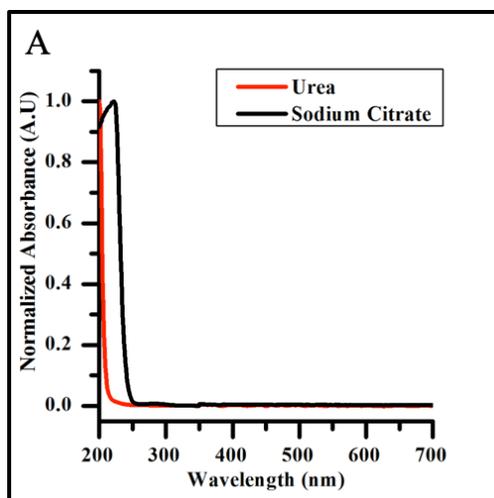


Survey XPS spectra for undoped CDs (A), 1:2 NCDs (B), 1:10 NCDs (C), and 1:25 NCDs (D).

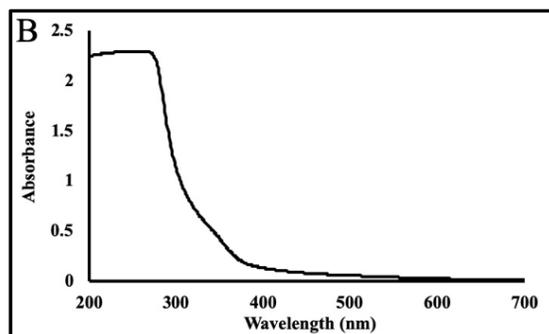


High resolution C(1s) XPS spectra for undoped CDs (A), 1:2 NCDs (B), 1:10 NCDs (C), and 1:25 NCDs (D). All spectra, despite different concentrations of urea present during synthesis, demonstrate similar carbon bonding environments including graphitic C-C/C=C (284.8 eV)¹, hydroxyl/carboxylic acid C-OH/C-O-C groups (286 eV)², and C=O groups (288.5 eV)¹

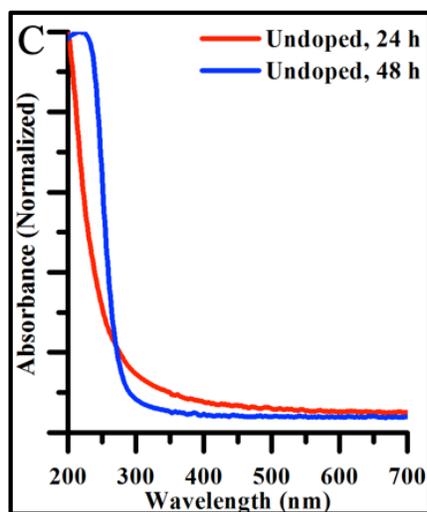
S4. Suplimental Absorbance Spectra



A) Absorbance spectra for urea and sodium citrate stock solutions.

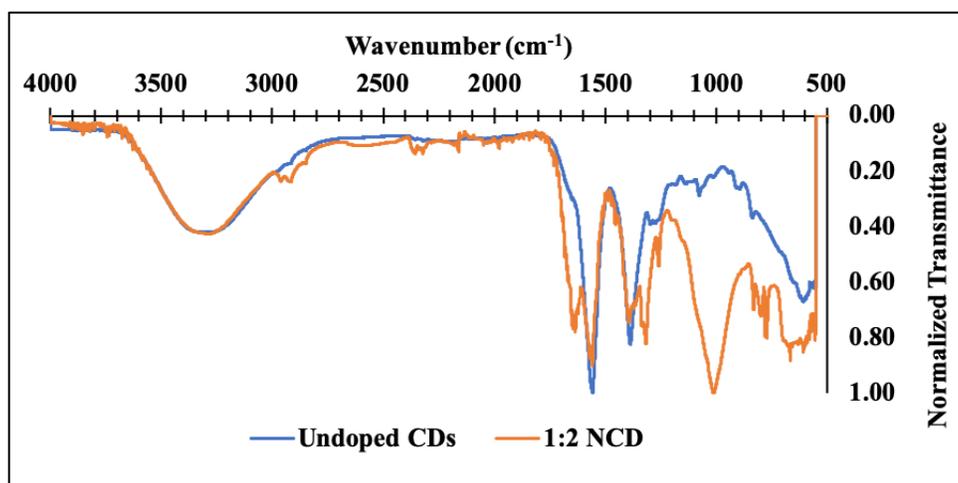


B) Absorbance spectra of undialyzed undoped CDs synthesized for 4hr at 200°C.



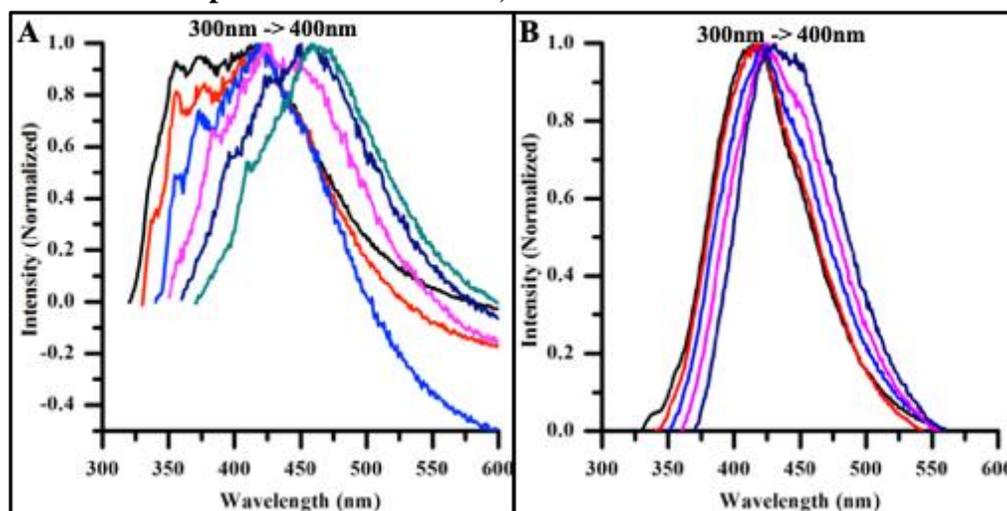
C) Absorbance spectra of undoped CDs synthesized for varying reaction times.

S5. FTIR spectrum of CD and NCDs



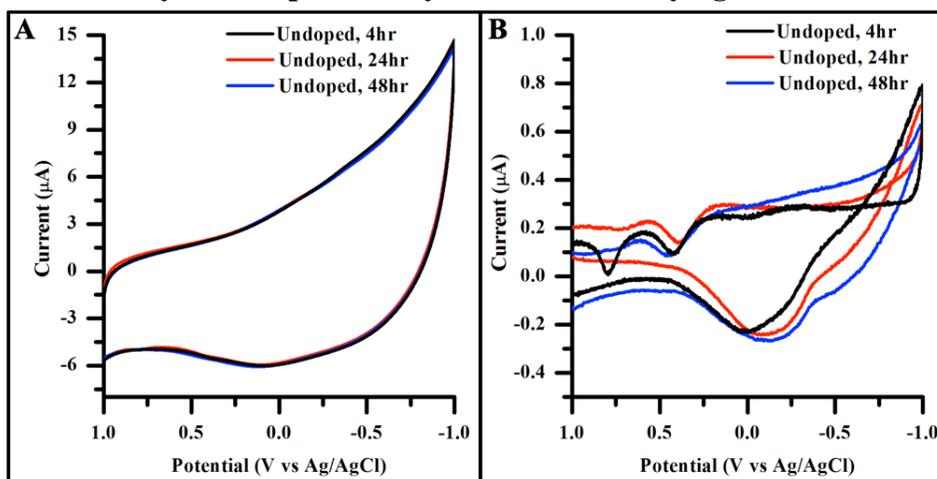
FTIR spectra for CD and 1:2 NCDs. From the spectra, oxygen containing functional groups could be identified on both CD and 1:2 NCD samples (OH stretch: $3300\text{-}3400\text{ cm}^{-1}$; CH bend: 1386 cm^{-1}). Additional peaks in the 1:2 NCD IR spectra could be assigned to nitrogen containing functional groups (CN stretch: 1315 cm^{-1} NH bend: 1634 cm^{-1} , $3100\text{-}3500\text{ cm}^{-1}$) suggesting incorporation of dopant into both the core and the surface of the final product.

S6. Fluorescence of undoped CD and 1:2 NCD, reacted for 24 h



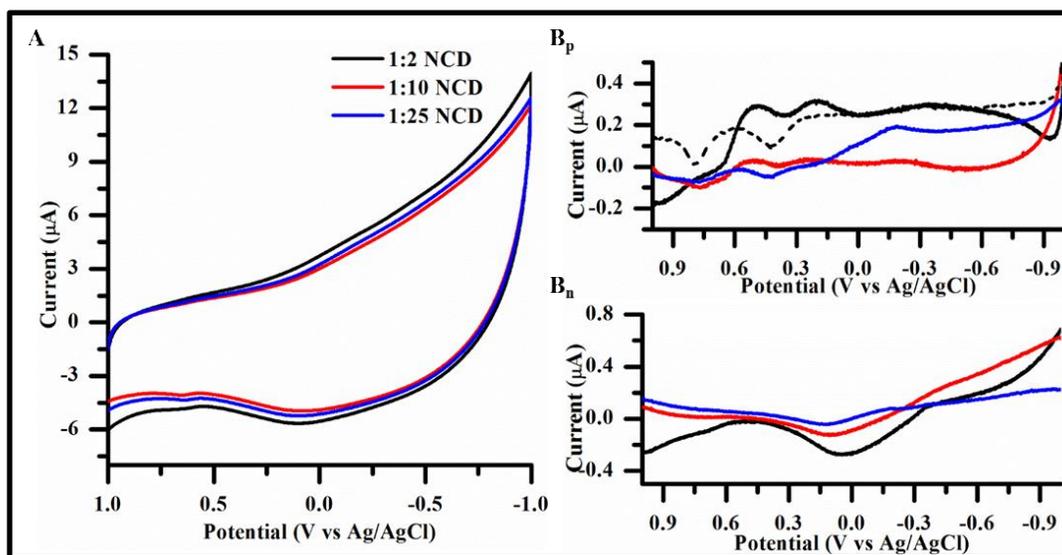
Normalized emission spectra under multiple excitation wavelengths of undoped CDs (A) and 1:2 NCDs (B) synthesized under hydrothermal reaction parameter for 24 h. Upon longer reaction times, the emission of CD and NCD materials shifts to excitation dependent behavior.

S7. Cyclic Voltammetry of undoped CDs synthesized for varying times



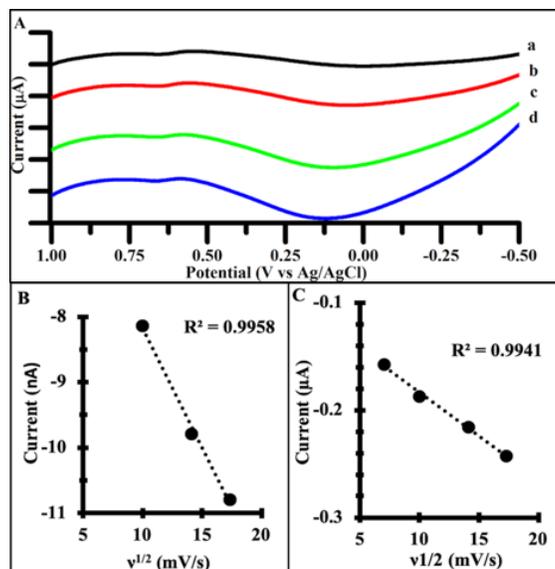
Cyclic voltammograms (A) and background subtracted voltammograms (B) of undoped CDs synthesized for varying times. All undoped CD materials exhibited similar oxidative behavior and similar oxidative peak potentials independent of reaction length.

S8. Full NCD cyclic voltammograms and background subtracted negative scan



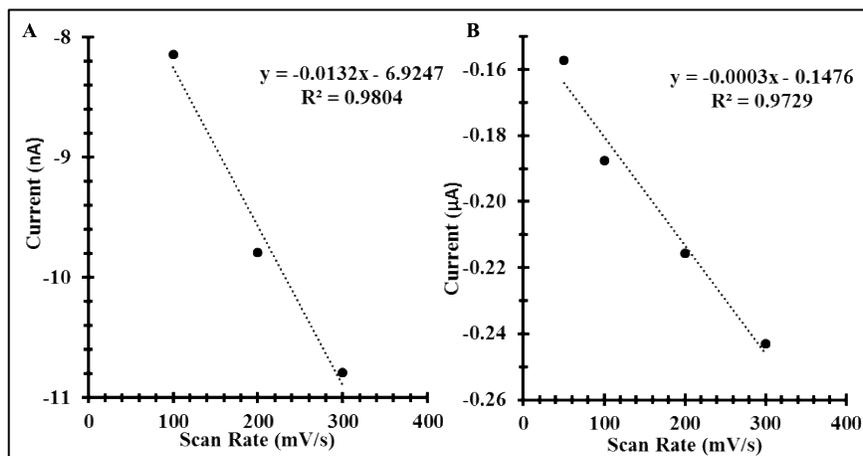
Complete cyclic voltammograms (A) of different batches of NCD materials synthesized under different doping ratios. The background subtracted scans are also shown, separated into their respective positive (B_p) and negative (B_n) scans in order to better resolve the oxidative peaks.

S9. Correlation between peak current and scan rate^{1/2} (v^{1/2}) for NCDs



A) Linear sweep voltammetry of 1:2 NCD samples measured at 50, 100, 200, and 300mV/s (a-d). Plot of peak current vs $v^{1/2}$ for $E_{ox,1}$ (B) and $E_{ox,2}$ (C). Equation of the line and R^2 values displayed for line of best fit. Variance with v shown in Figure S8.

S10. Correlation between peak current and scan rate (v) for NCD materials



Correlation between peak current (v) and scan rate for the oxidation peaks at ~0.3V (A) and ~0.6V (B) seen in the cyclic voltammograms of 1:2 NCD samples.