

## Supporting Information

### Pyridinic N Doped Graphene: Synthesis, Electronic Structure, and Electrocatalytic Property

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#### Calculation of electron transfer numbers in ORR:

The electron transfer numbers were calculated using Koutecky-Levich equation.<sup>S1</sup>

$$\bar{i}^{-1} = i_k^{-1} + i_{lev}^{-1};$$

$$i_k = nFK_{O_2}C_{O_2}\Gamma_{catalyst};$$

$$i_{lev} = 0.62nF C_{O_2} D_{O_2}^{2/3} \nu^{-1/6} \omega^{1/2};$$

$$\bar{i}^{-1} = A + 1/(B\omega^{1/2});$$

$$B = 0.62nF C_{O_2} D_{O_2}^{2/3} \nu^{-1/6};$$

where,  $i$  is the total current density;  $i_k$  is the kinetic current density;  $i_{lev}$  is the levich current density;  $n$  is the electron transfer numbers;  $F$  is the Faraday constant ( $96500 \text{ C mol}^{-1}$ );  $\Gamma_{catalyst}$  is the catalyst loading;  $k_{O_2}$  is the rate constant for oxygen reduction;  $C_{O_2}$  is concentration of  $O_2$  dissolved in 0.1 M KOH solution ( $1.2 \times 10^{-6} \text{ mol cm}^{-3}$ );  $D_{O_2}$  is the diffusion coefficient of  $O_2$  in 0.1 M KOH solution ( $1.9 \times 10^{-5} \text{ cm}^2 \text{ s}^{-1}$ );  $\omega$  is the rotation rate ( $\text{rad s}^{-1}$ ) and  $\nu$  is the kinetic viscosity of the water ( $0.01 \text{ cm}^2 \text{ s}^{-1}$ ). The slope of the plot of reciprocal current  $\bar{i}^{-1}$  versus the reciprocal square root of rotation rate ( $\omega^{-1/2}$ ) gives B values. The value of  $n$  can be calculated from B by using above parameters.<sup>S1</sup>

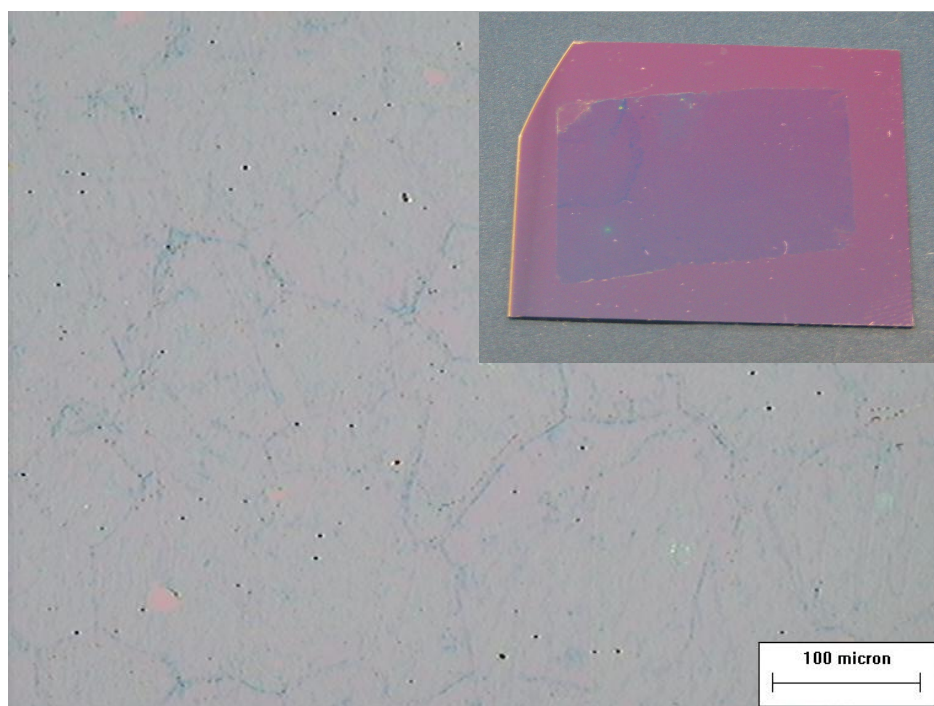


Figure S1. Optical image of single layer graphene transferred onto a SiO<sub>2</sub>/Si substrate. The inset shows a photograph of the single layer graphene transferred onto a SiO<sub>2</sub>/Si substrate.

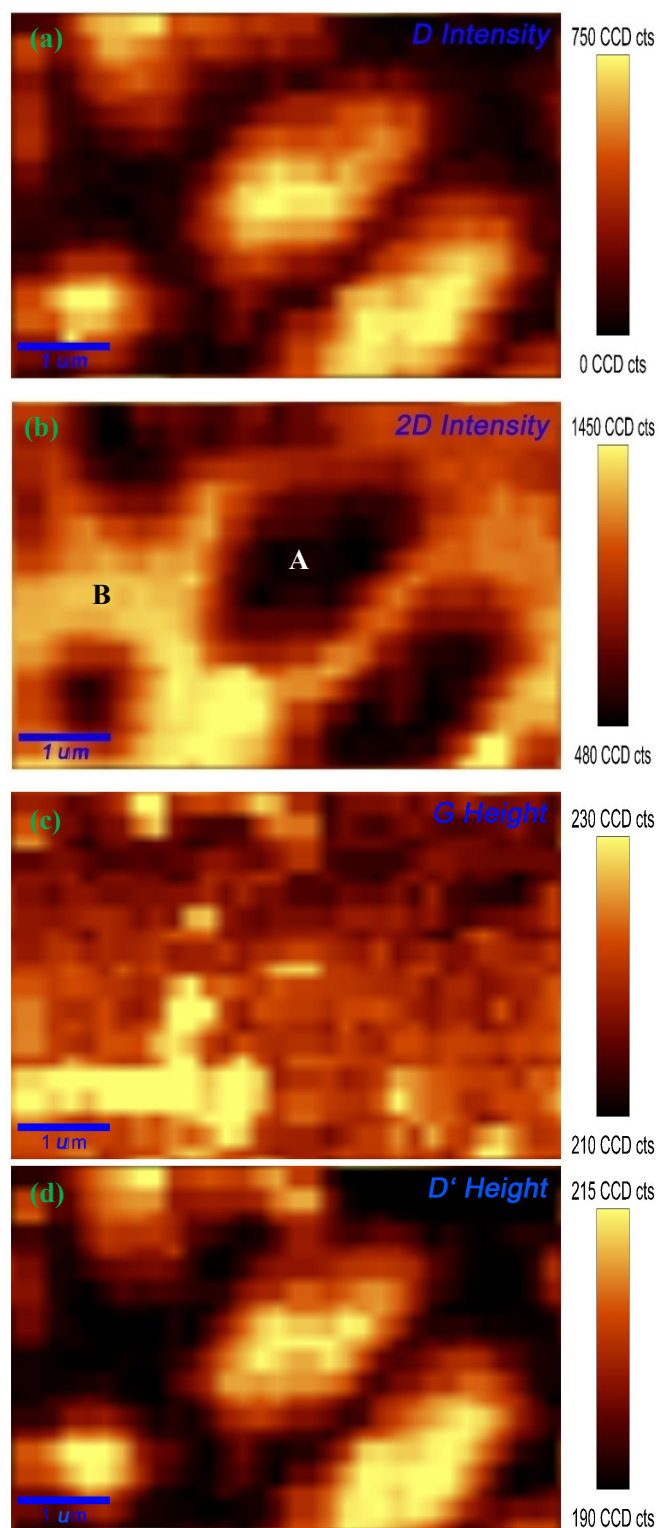


Figure S2. Raman imaging of  $\text{CN}_x$  graphene synthesized with the  $\text{NH}_3/\text{He}$  flow rate of 12 sccm (GN12). (a) D band intensity, (b) 2D band intensity, (c) G band height, (c) D' band height.

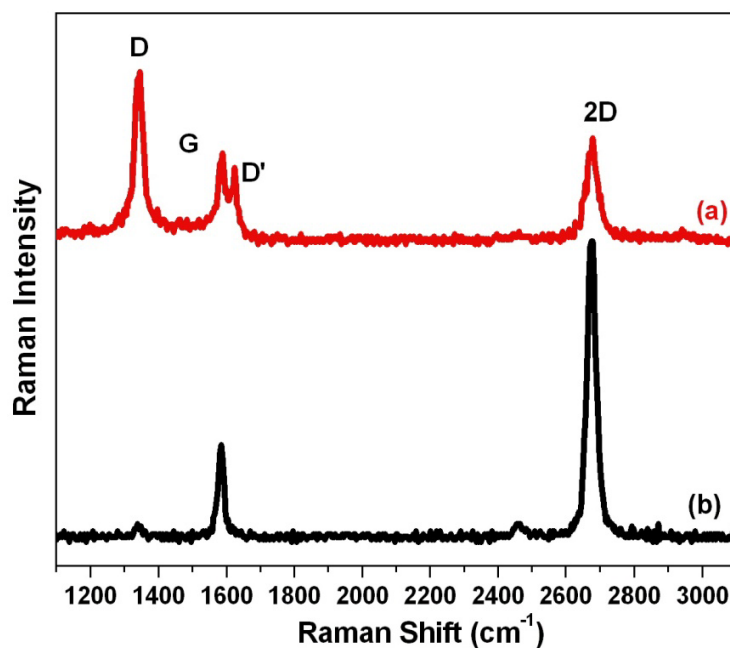


Figure S3. Raman spectra of the  $\text{CN}_x$  graphene synthesized with the  $\text{NH}_3/\text{He}$  flow rate of 12 sccm (GN12). Spectrum (a) and spectrum (b) corresponds to the A and B spots in Figure S1, respectively.

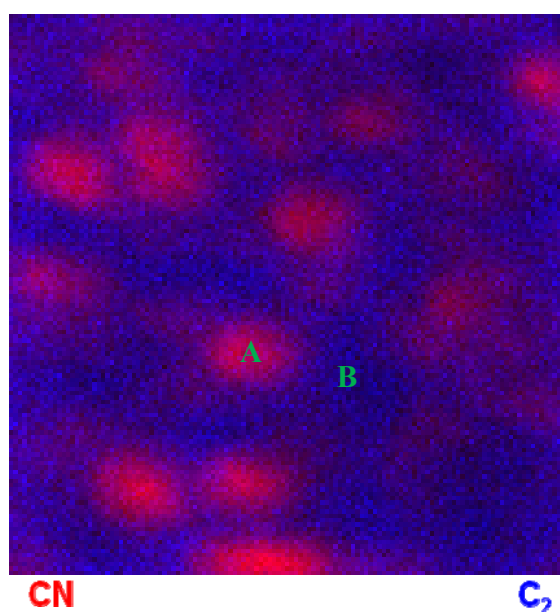


Figure S4. Overlay imaging of  $\text{CN}^-$  and  $\text{C}_2^-$  mass spectra images shown in Figure 3. N rich area is demonstrated with the red color.

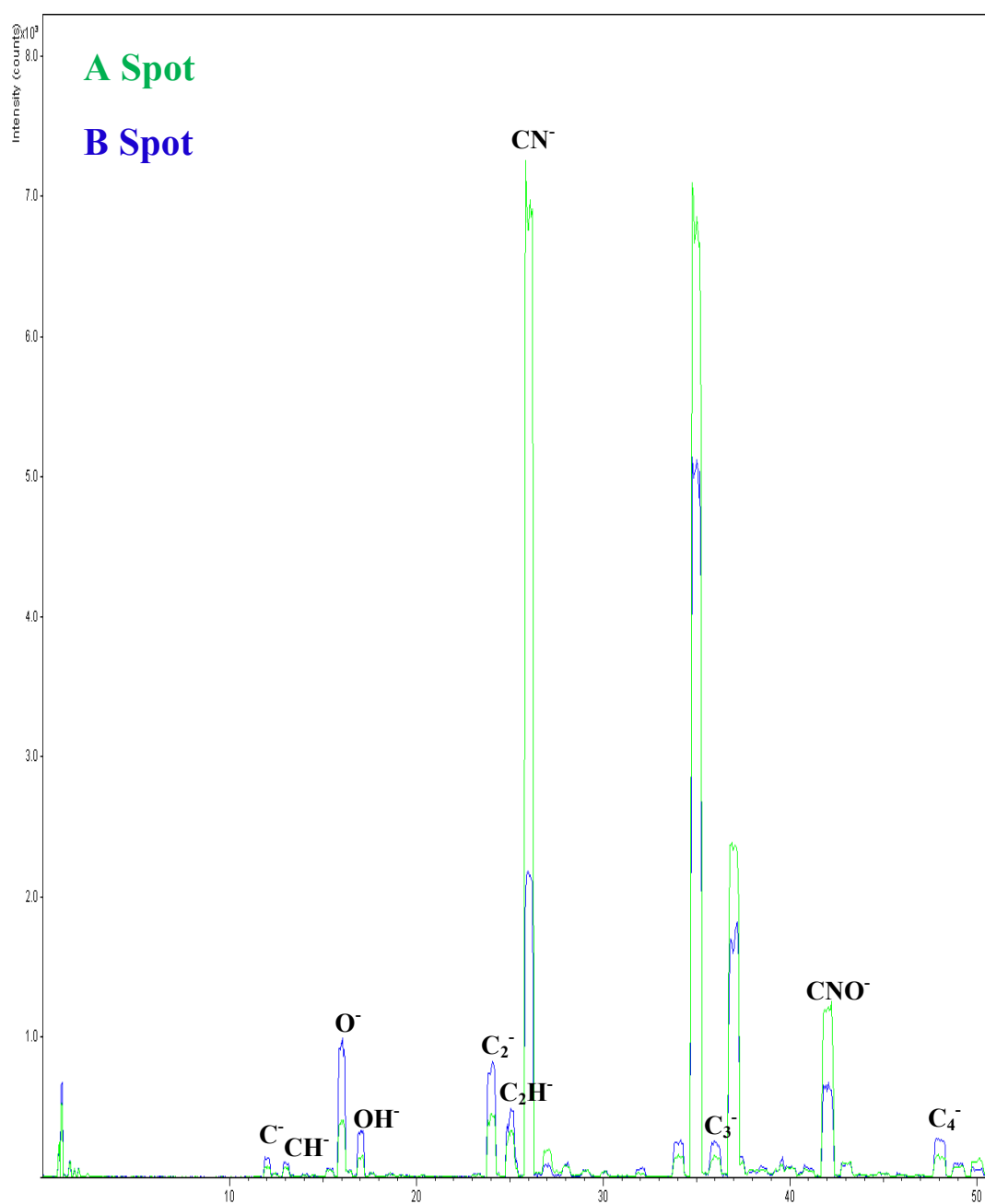


Figure S5. TOF-SIMS mass spectra in linear scale from the A and B spots indicated in Figure S4.

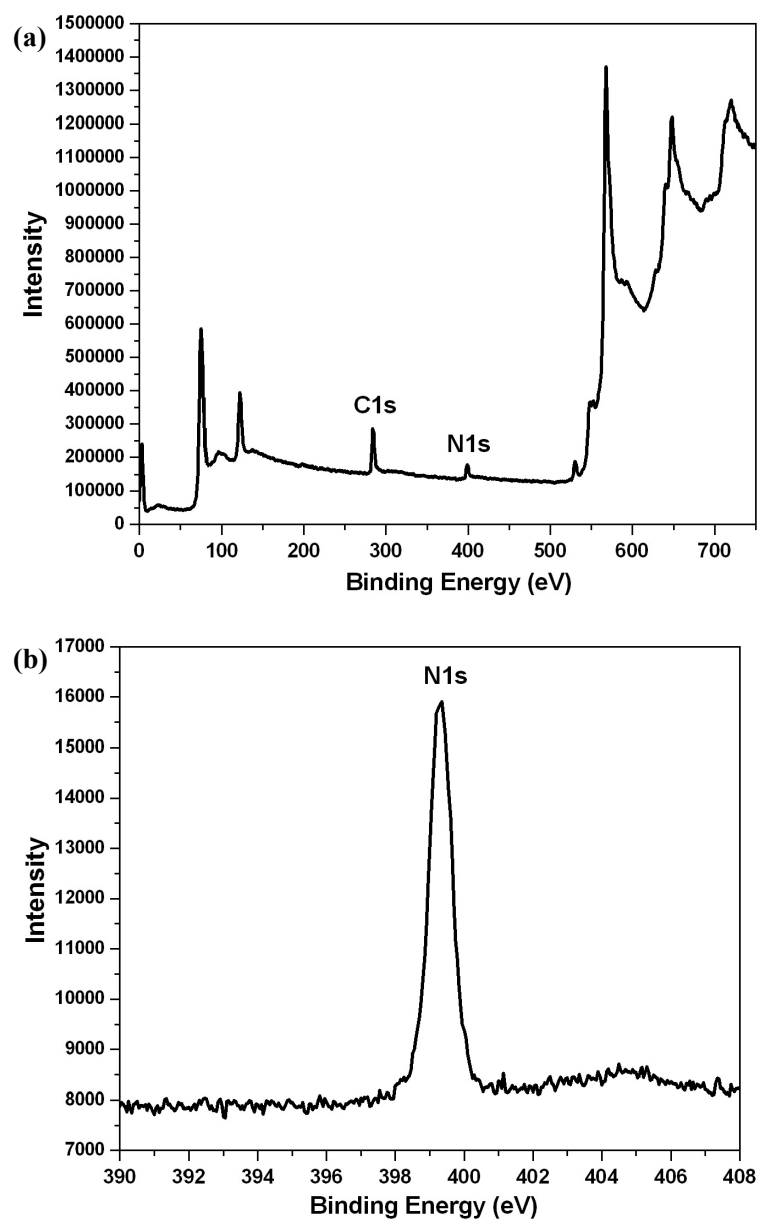


Figure S6. (a) XPS survey scan of  $\text{CN}_x$  graphene synthesized with the  $\text{NH}_3/\text{He}$  flow rate of 6 sccm (GN6), (b) N1s core-level spectrum.

## Reference

S1. J. Zhang, (Eds.) *PEM Fuel Cell Electrocatalysts and Catalyst Layers* (Springer). 2008, 89-109