# Supplementary Information

**Facile synthesis of templated activated carbon from cellulose nanofibers and MgO nanoparticles *via* integrated carbonization-activation method as an eco-friendly supercapacitor**

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Figure S1. SEM image of MgO NPs with an average size of 52.6 ± 5.9 nm.



Figure S2. TGA curves of a) formed Mg(OH)2 formed as a result of mixing TOCN with MgO in water, and b) KOH.



Figure S3. GCD curves of a) TAC-C600 and b) TAC-C700 at varying current densities.



Figure S4. XPS spectra (wide, K2s, and Mg1s) of a) TAC-C600, b) TAC-C700, and c) TAC-C800. Note that the non-highlighted peaks are all from the indium pellet used to adhere the powdered TAC onto for XPS analysis.



Figure S5. CV and GCD curves for TAC-KxM30 (a, b), and TAC-K5Mx (c, d), respectively.

Table S1. *S*BET, BJH pore volume analysis, and XPS elemental composition of TAC-K5Mx and TAC-KxM30.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample | *S*BET /  | BJH *V*total / | BJH *V*micro /  | BJH *V*meso-macro /  | XPS |
| m2 g-1 | cm3 g-1 | cm3 g-1 | % | cm3 g-1 | % | C at% | O at% | O/C |
| TAC-K5Mx | 1343 | 0.40 | 0.32 | 79.7 | 0.08 | 20.3 | 87.49 | 12.51 | 0.143 |
| TAC-KxM30 | 1196 | 0.61 | 0.18 | 27.6 | 0.48 | 72.4 | 90.46 | 9.54 | 0.105 |

Table S2. Deconvoluted Raman spectra peaks and their corresponding ratios with respect to the G-band for TAC samples with varying amounts of KOH.

|  |  |  |  |
| --- | --- | --- | --- |
| Sample | *I*D/*I*G | *I*P/*I*G | *I*Am/*I*G |
| TAC-K2 | 1.18 | 0.43 | 0.54 |
| TAC-K5 | 1.15 | 0.35 | 0.51 |
| TAC-K7 | 1.20 | 0.35 | 0.49 |
| TAC-K10 | 1.20 | 0.40 | 0.62 |

Table S3. XPS C1s and O1s narrow spectra peak identification for TAC with varying amounts of KOH.

|  |  |  |
| --- | --- | --- |
| Sample | C1s | O1s |
| C at% | Group | B.E. eV | Conc. at% | O at% | Group | B.E. eV | Conc. at% |
| TAC-K2 | 86.35 | C-C/C=C | 284.8 | 37.9 | 13.65 | C-O | 532.3 | 92.5 |
| C-O | 286.1 | 23.3 | C=O | 536.6 | 7.5 |
| C=O | 288.2 | 35.6 |  |
| π→π\* | 292.2 | 1.2 |
| TAC-K5 | 88.07 | C-C/C=C | 285.0 | 50.2 | 11.93 | C-O | 532.4 | 90.3 |
| C-O | 286.5 | 19.4 | C=O | 537.1 | 9.7 |
| C=O | 288.3 | 18.9 |  |
| π→π\* | 290.7 | 11.5 |
| TAC-K7 | 86.24 | C-C/C=C | 285.0 | 40.0 | 13.76 | C-O | 532.4 | 92.7 |
| C-O | 286.4 | 42.1 | C=O | 536.5 | 7.3 |
| C=O | 289.0 | 6.7 |  |
| π→π\* | 290.1 | 11.2 |
| TAC-K10 | 86.69 | C-C/C=C | 284.9 | 45.9 | 13.31 | C-O | 532.4 | 88.5 |
| C-O | 286.3 | 19.2 | C=O | 536.7 | 11.5 |
| C=O | 288.6 | 34.9 |  |

Table S4. Deconvoluted Raman spectra peaks and their corresponding ratios with respect to the G-band for TAC samples with varying amounts of MgO.

|  |  |  |  |
| --- | --- | --- | --- |
| Sample | *I*D/*I*G | *I*P/*I*G | *I*Am/*I*G |
| TAC-M5 | 1.18 | 0.28 | 0.48 |
| TAC-M10 | 1.15 | 0.35 | 0.51 |
| TAC-M30 | 1.26 | 0.48 | 0.65 |
| TAC-M50 | 1.21 | 0.42 | 0.64 |

Table S5. XPS C1s and O1s narrow spectra peak identification for TAC with varying amounts of MgO.

|  |  |  |
| --- | --- | --- |
| Sample | C1s | O1s |
| C% | Group | B.E. eV | Conc. at% | O% | Group | B.E. eV | Conc. at% |
| TAC-M5 | 83.46 | C-C/C=C | 285.0 | 44.0 | 16.54 | C-O | 532.3 | 89.5 |
| C-O | 286.4 | 31.8 | C=O | 536.4 | 10.5 |
| C=O | 289.0 | 17.7 |  |
| π→π\* | 291.4 | 6.5 |
| TAC-M10 | 88.07 | C-C/C=C | 285.0 | 50.2 | 11.93 | C-O | 532.4 | 90.3 |
| C-O | 286.5 | 19.4 | C=O | 537.1 | 9.7 |
| C=O | 288.3 | 18.9 |  |
| π→π\* | 290.7 | 11.5 |
| TAC-M30 | 84.99 | C-C/C=C | 285.0 | 43.2 | 15.01 | C-O | 532.3 | 94.3 |
| C-O | 285.4 | 16.0 | C=O | 537.1 | 12.11 |
| C=O | 288.0 | 31.2 |  |
| π→π\* | 291.4 | 9.7 |
| TAC-M50 | 87.34 | C-C/C=C | 284.9 | 41.0 | 12.66 | C-O | 532.3 | 89.8 |
| C-O | 286.1 | 24.7 | C=O | 536.2 | 10.2 |
| C=O | 287.8 | 20.6 |  |
| π→π\* | 290.7 | 13.7 |

Table S6. Deconvoluted Raman spectra peaks and their corresponding ratios with respect to the G-band for TAC samples activated at varying temperatures.

|  |  |  |  |
| --- | --- | --- | --- |
| Sample | *I*D/*I*G | *I*P/*I*G | *I*Am/*I*G |
| TAC-C600 | 0.996 | 0.400 | 0.687 |
| TAC-C700 | 1.184 | 0.408 | 0.641 |
| TAC-C800 | 1.255 | 0.475 | 0.649 |

Table S7. XPS C1s and O1s narrow spectra peak identification for TAC activated at varying temperatures.

|  |  |  |
| --- | --- | --- |
| Sample | C1s | O1s |
| C at% | Group | B.E. eV | Conc. at% | O at% | Group | B.E. eV | Conc. at% |
| TAC-C600 | 83.55 | C-C/C=C | 284.6 | 44.2 | 16.45 | C-O | 532.4 | 90.25 |
| C-O | 286.3 | 34.5 | C=O | 536.8 | 9.75 |
| C=O | 289.2 | 16.2 |  |
| π→π\* | 291.9 | 5.1 |
| TAC-C700 | 82.95 | C-C/C=C | 284.9 | 47.3 | 17.05 | C-O | 532.3 | 89.5 |
| C-O | 286.4 | 15.8 | C=O | 537.5 | 10.5 |
| C=O | 288.3 | 26.2 |  |
| π→π\* | 291.2 | 10.7 |
| TAC-C800 | 84.99 | C-C/C=C | 285.0 | 43.2 | 15.01 | C-O | 532.3 | 94.3 |
| C-O | 285.4 | 16.0 | C=O | 537.1 | 12.11 |
| C=O | 288.0 | 31.2 |  |
| π→π\* | 291.4 | 9.7 |