Supporting Information

Enhanced capacitor effects in polyoxometalate/grapheme nanohybrid materials; a synergetic approach to high performance energy storages

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Characterization of the POM/RGO nanohybrid materials

Figure S2 shows the IR spectra of RGO, TBA$_3$[PMo$_{12}$O$_{40}$], and the POM/RGO hybrid. They indicate the presence of the [PMo$_{12}$O$_{40}$]$^{3-}$ anion in the POM/RGO hybrid material with little structural change from that in TBA$_3$[PMo$_{12}$O$_{40}$]. The resonant Raman spectra of the as-prepared RGO and the POM/RGO hybrid were measured at the excitation wavelength of 514 nm (see Fig. S3). These two samples exhibit the G (1583 cm$^{-1}$) and D (1348 cm$^{-1}$) bands, which are assignable to the first-order scattering of the $E_{2g}$ vibration mode for the sp$^2$ domains of graphene and the breathing mode of the $k$-point phonons of $A_{1g}$ symmetry, respectively.$^{S1}$ The intensity ratio of the D and G bands, which is known to reflect the degree of disorder and the average size of the sp$^2$ domains,$^{S1}$ is 1.4 or 1.0 for RGO or POM/RGO, respectively. This small difference between the two values means that the nanohybridization does not bring about a significant change in the sp$^2$ domains of graphenes.

References

Figure S1. SEM image of cathode materials in POM-MCB.

Figure S2. (a) TEM image of RGO, (b) Magnified TEM image of RGO
Figure S3. IR spectra of the POM, RGO, and POM/RGO hybrid materials. The inset is a magnification for the range of 1200-7000 cm$^{-1}$. Arrows indicate peaks assigned to POMs.

Figure S4. Raman spectra of the as-prepared RGOs and POM/RGO hybrid materials.
Figure S5. First ten cycle charge/discharge curves of POM/RGO hybrid (a), POM/SWNT hybrid (b), and microcrystal-POM MCBs (c).
Figure S6. Operando Mo K-edge XANES spectra for the POM/RGO MCBs in the first discharge process.
Figure S7. (a) 1st discharge curves and (b) cycle performances of the POM/RGO MCBs at 1, 2 and 4 mA.
Figure S8. (a) 1st discharge curves and (b) cycle performances of the POM/RGO and the POM/SWNT hybrid MCBs at 1, 2 and 4 mA.

Figure S9. Power density plots for the POM/RGO MCBs at 1, 2 and 4 mA.