ELECTRONIC SUPPORTING INFORMATION

High-performance aqueous asymmetric electrochemical capacitor based on graphene oxide / cobalt(II)-tetrapyrazinoporphyrazine hybrids

Joel Leketima,[a] Kenneth I. Ozoemena,*[,a,b] Charl J. Jafta,[b,c] Nagao Kobayashi,*[,d] Yang Song,[e] Dennis Tong,[e] Shaowei Chen,*[,e] and Munetaka Oyama[f]

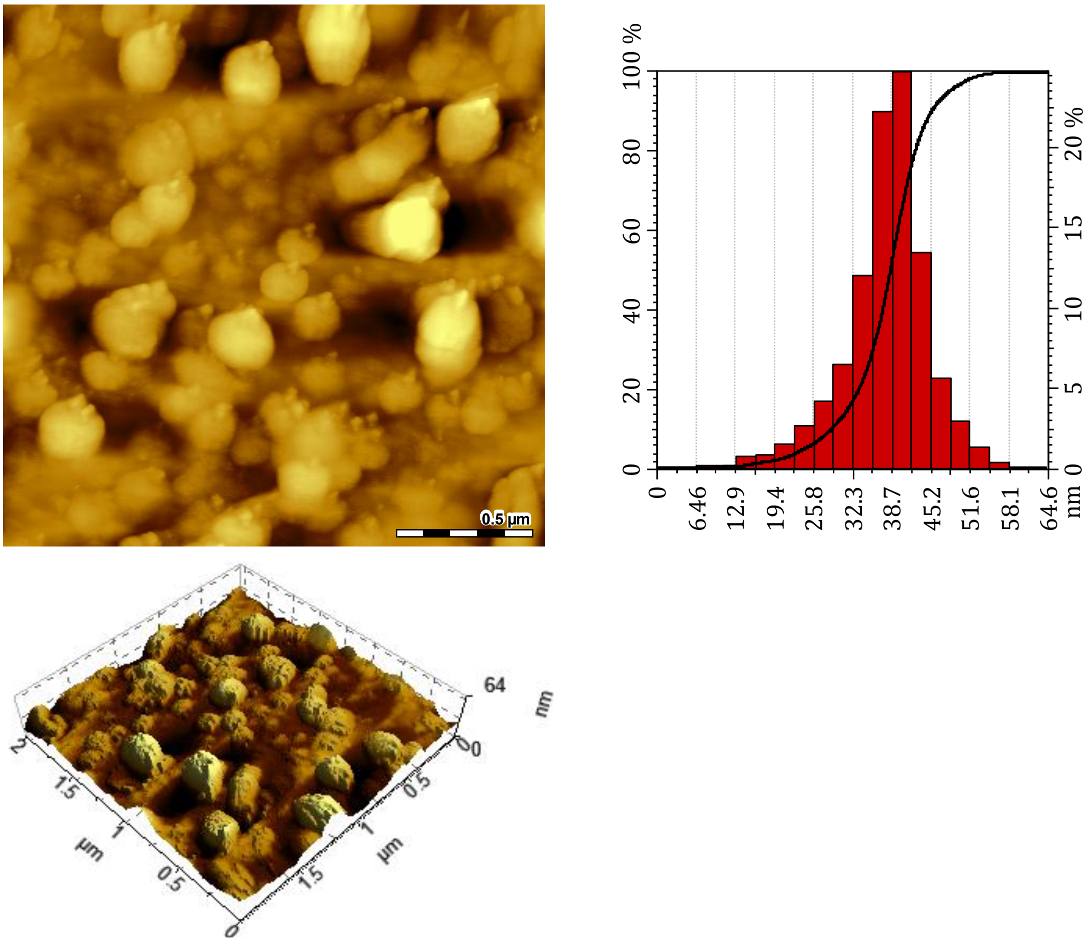

Figure SI 1: AFM images of the GO/CoTPyzPz hybrid.

From the Raman spectra (Figure SI 2), both GO and GO/CoTPyzPz show same peak positions for the D and G peaks at 1338 and 1577 cm^{-1}, respectively. However, there is a marginal increase in the D to G band intensity ratio, I_D/I_G, from 0.87 to 0.91 upon integration with the CoTPyzPz. The increased D band intensity reflects a disorder in the carbon structure. The stronger D peak intensity observed in the GO/CoTPyzPz is related to the smaller size of the GO/CoTPyzPz compared to the pristine GO, which is a reflection of more defects. The strongest peak at 1521 cm^{-1} for CoTPyzPz mainly involves stretching of C–N–C and C–N bonds coupling with expanding of pyrroles.[1] The second strongest peak at 1327 cm^{-1} for CoTPyzPz mainly involves stretching of the pyrroles and N–Co bonds coupling with C–H and C–N–C bonds in-plane bending. The weak peak at 655 cm^{-1} for CoTPyzPz is associated with expanding of pyrrole rings and stretching of N–Co. The shoulder vibration mode at 455 cm^{-1} is typical N–H vibrations. The integration with the GO led to an enhanced but a broad vibration mode at 674 cm^{-1} for the GO/CoTPyzPz, suggesting more expanded pyrrole rings and stretching of the N–Co bond.[1]

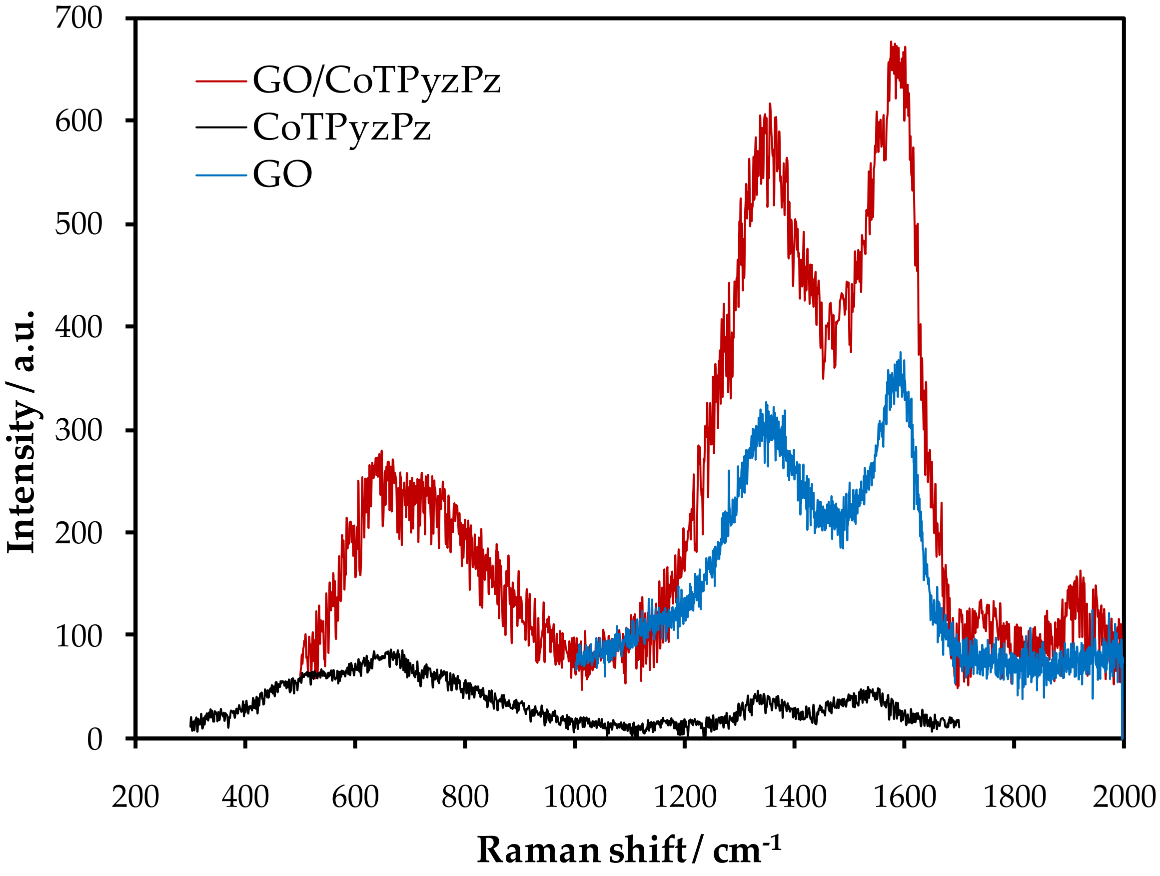

Figure SI 2: Comparative Raman spectra of the GO, CoTPyzPz and GO/CoTPyzPz hybrid.

From the IR spectra (Figure SI 3), the broad band at 3400 – 3100 cm^{-1} for is related to the O–H vibrations of the GO, N–H stretching vibrations for the CoTPyzPz, or the N–H / O–H vibrations for the GO/CoTPyzPz. As expected, the degenerate stretching vibrational modes of the pyrazine rings at 1521 cm^{-1} for the CoTPyzPz and GO/CoTPyzPz are more intensive than the similar modes of the benzene rings at 1572 cm^{-1} for the GO. The peak at the 1715 cm^{-1} for the GO is related to the C=O stretching vibrations.

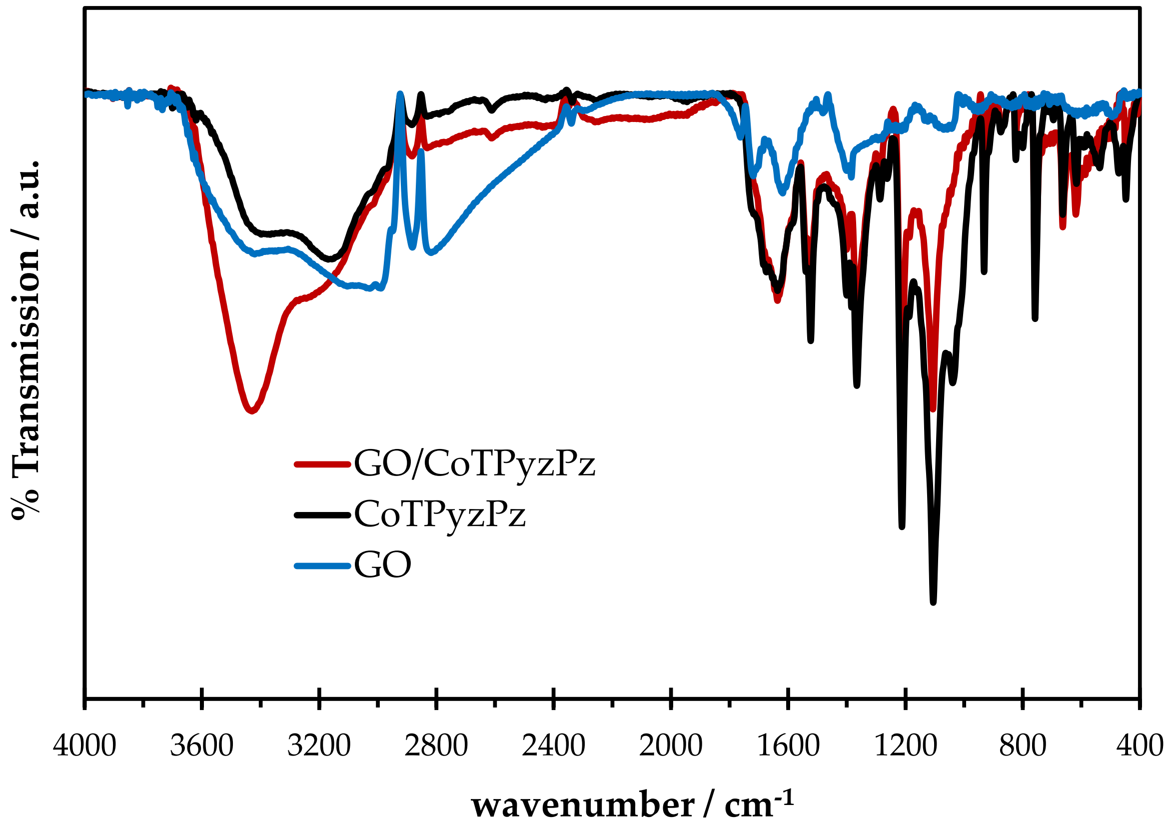

Figure SI 3: Comparative IR spectra of the GO, CoTPyzPz and GO/CoTPyzPz hybrid.

References

1. Z. Liu, X. Zhang, Y. Zhang, J. Jiang, Vibrational Spectroscopy 2007, **43**, 447.