

Supporting Information

Graphene oxide based BCNO hybrid nanostructures: tunable band gaps for full color white emission

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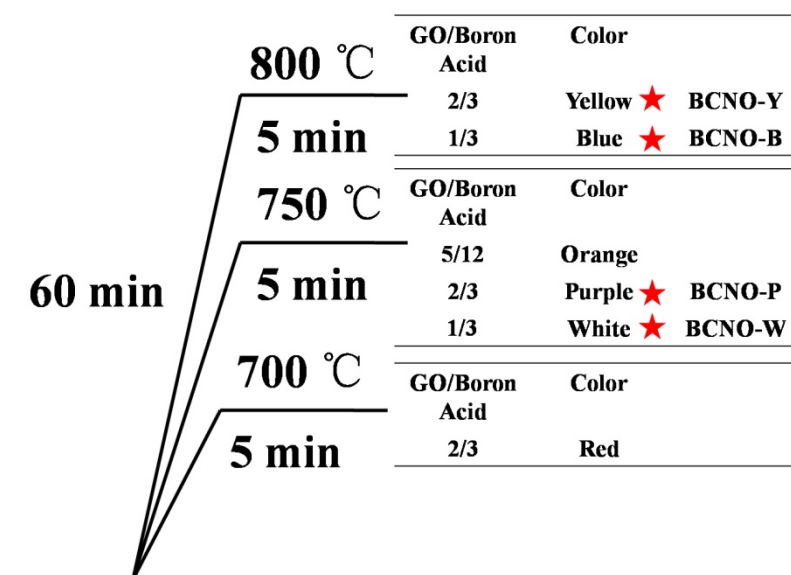


Figure S1. The weight ratios of GO/boron acid, heating procedures and lighting properties of the BCNO phosphors. The weigh ratio of urea / boron acid is fixed as 20. Four typical phosphors emitting yellow, blue, purple and white were marked with stars, and renamed as BCNO-Y, BCNO-B, BCNO-P, and BCNO-W respectively.

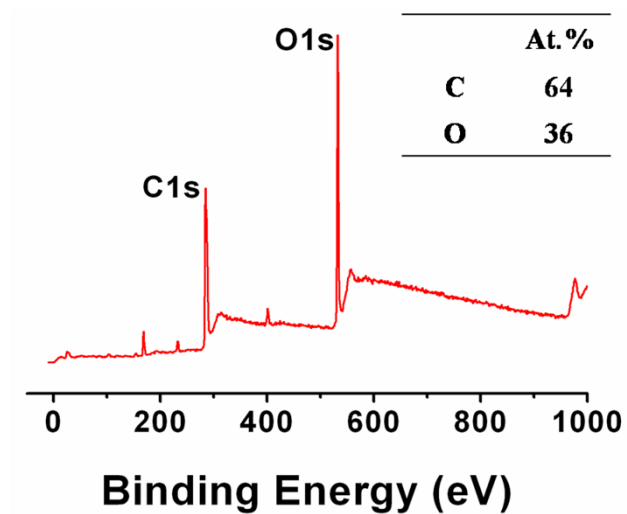


Figure S2. XPS full spectrum profiles of GO. It indicates that the atomic contents of C, and O are 64 at%, and 36 at% respectively.

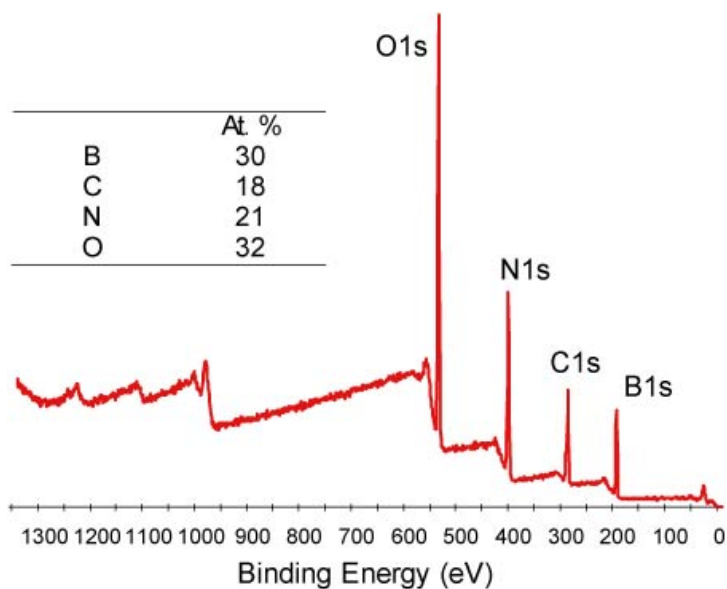


Figure S3. XPS profiles of BCNO-W phosphor. It indicates the atomic contents of B, C, N and O are 30 at%, 18 at%, 21 at% and 32 at% respectively.

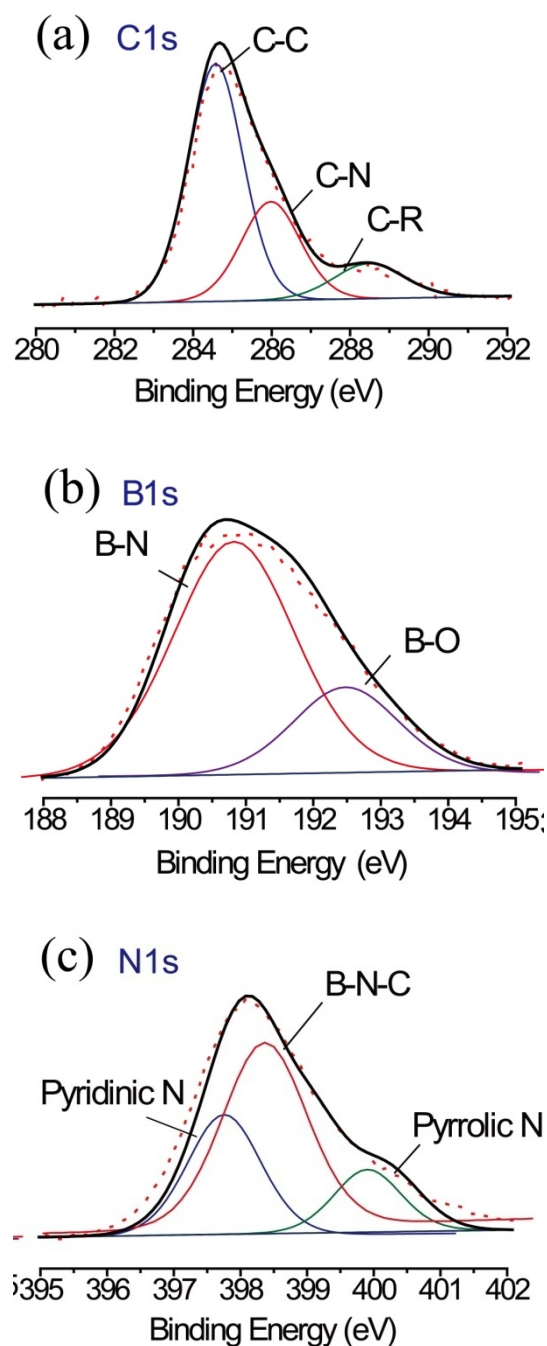


Figure S4. XPS profiles of BCNO-W phosphor recovered from warm water washing. The curves are deconvolved by Gaussian fitting, thereby indicating possible bonding structures. It shows that the recovered material is B-N-C type doped graphene containing only a slight fraction of boron oxide.

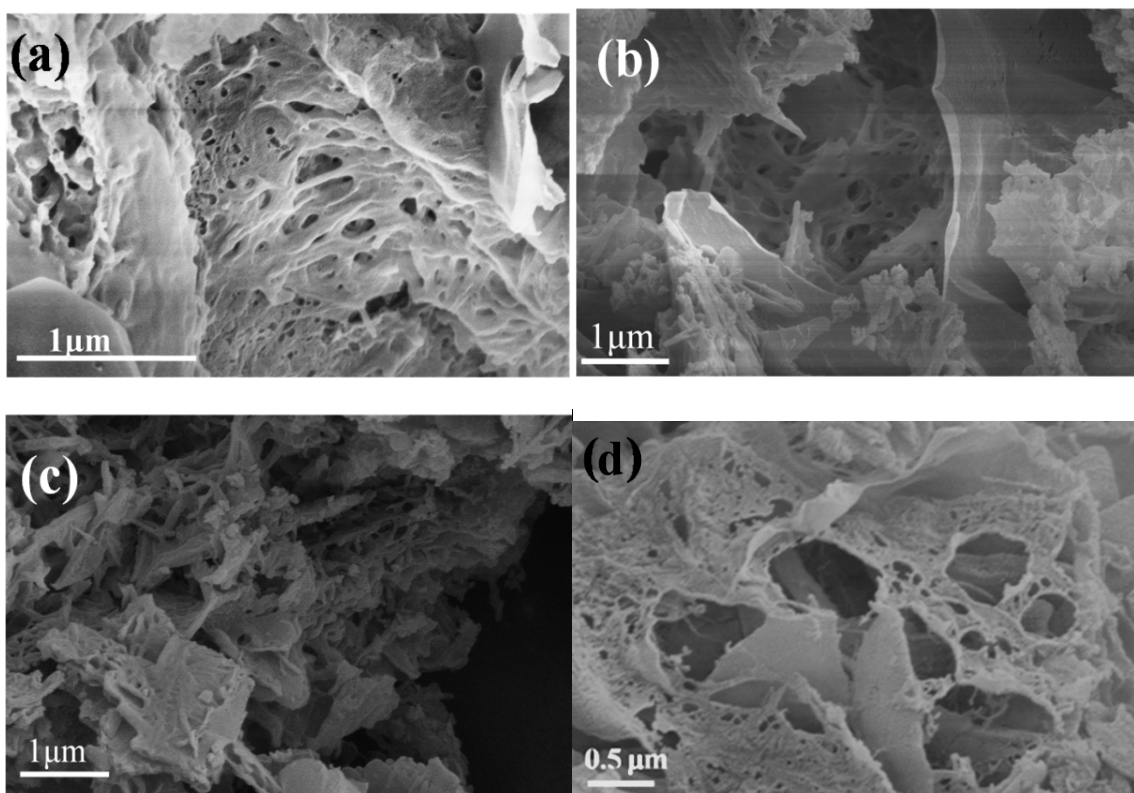


Figure S5. SEM images of (a) BCNO-Y, (b) BCNO-B, (c) BCNO-P and (d) BCNO-W phosphors. Porous graphene can be clearly observed. The image of BCNO-W phosphor is shown for comparison.

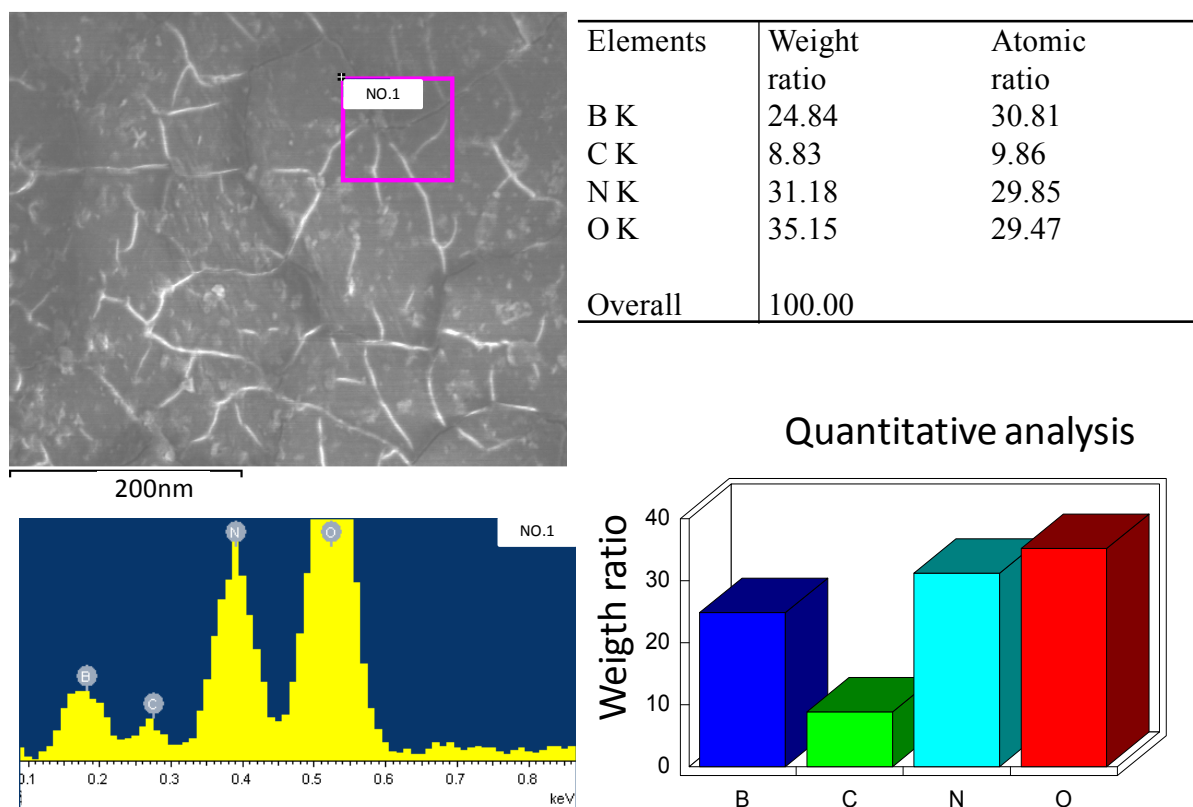


Figure S6. Energy dispersive X-ray spectroscopy (EDS) analysis of BCNO-W phosphor, indicating the B-C-N-O quaternary compound.

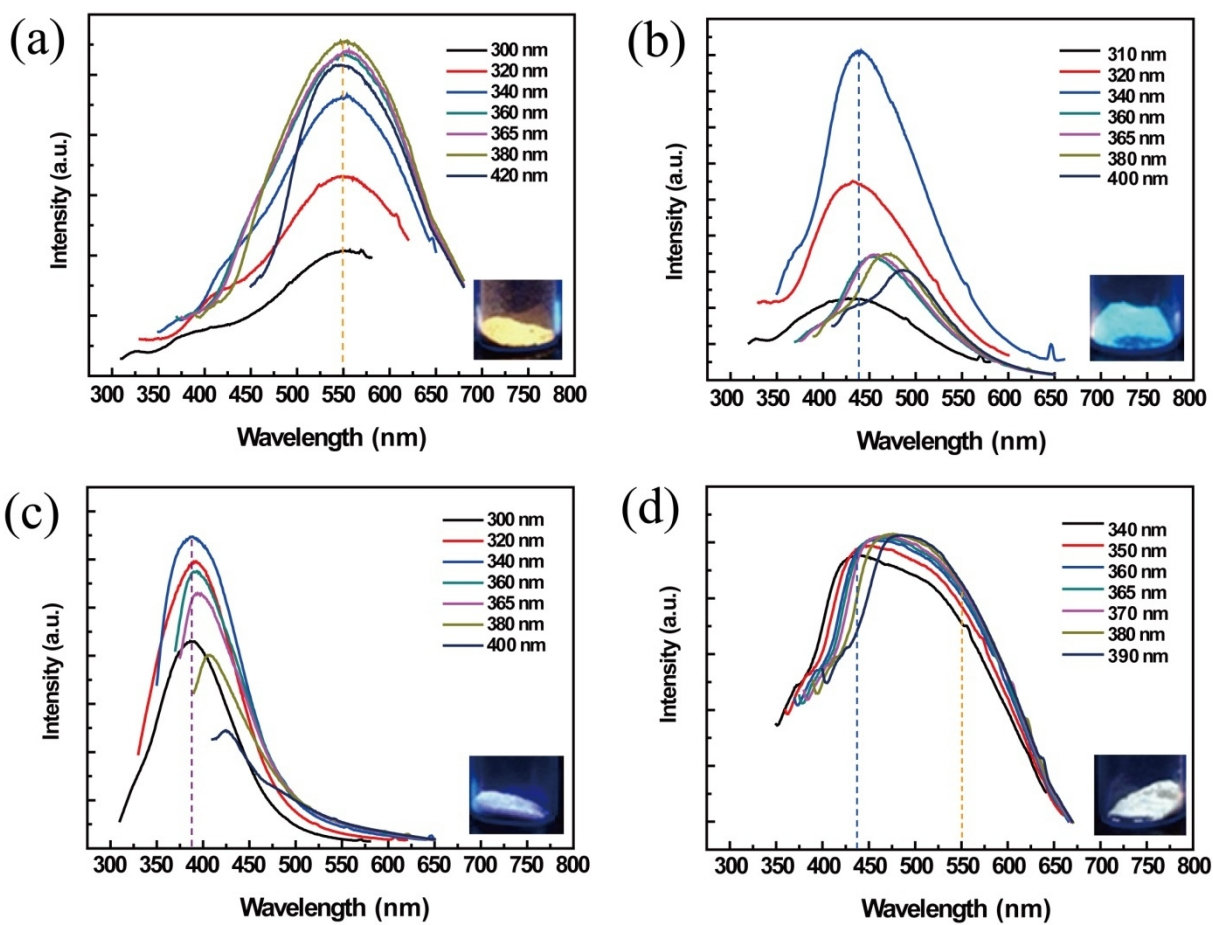


Figure S7. PL spectra of (a) BCNO-Y, (b) BCNO-B, (c) BCNO-P and (d) BCNO-W phosphors. Insets are the corresponding powders excited at 365nm. The spectra of BCNO-W phosphor is shown for comparison.

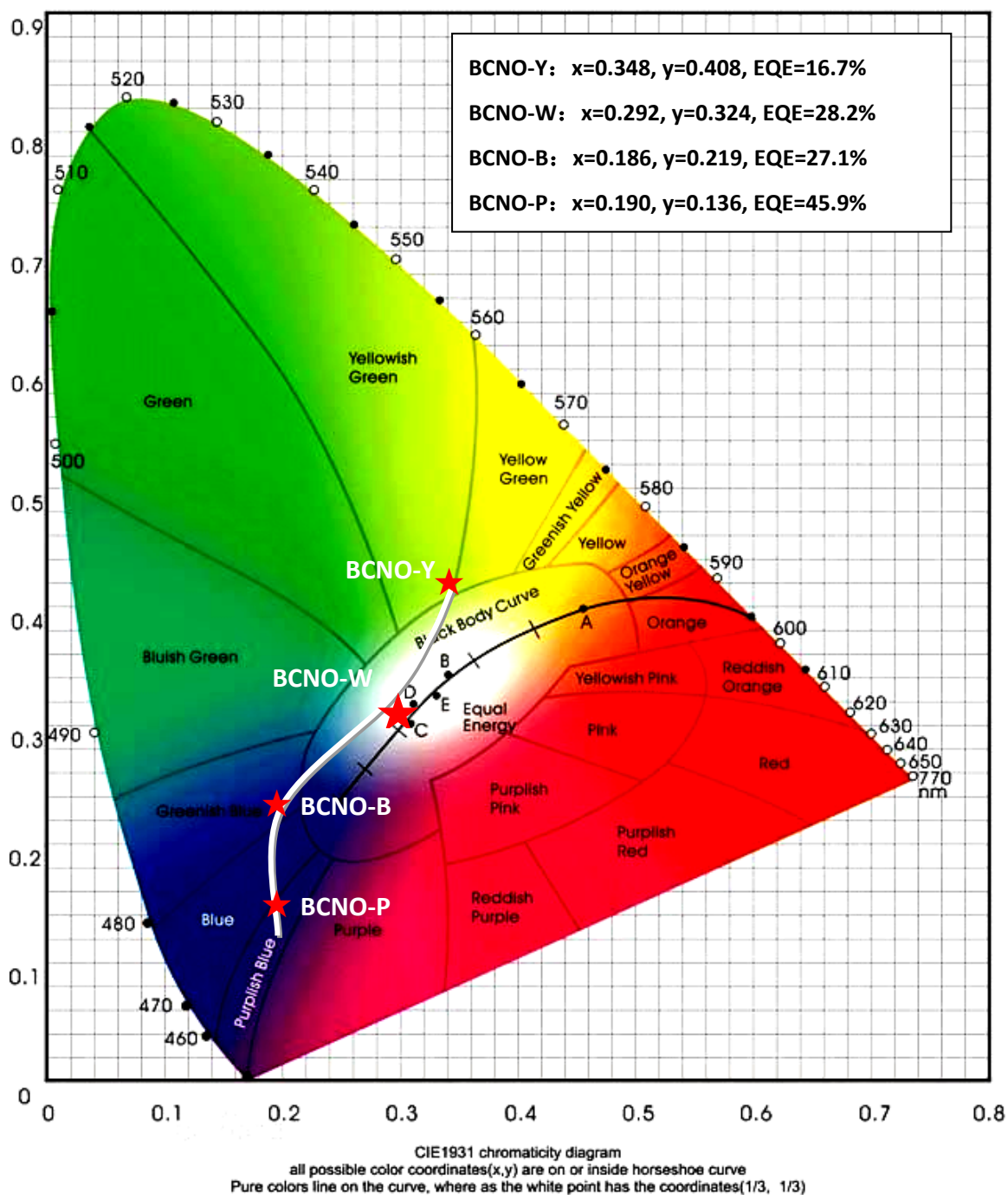


Figure S8. A Commission Internationale de l'Eclairage (CIE) diagram showing the emission colors of BCNO-Y, BCNO-W, BCNO-B, and BCNO-P phosphors excited at 365nm. The line is drawn to guide eyes.

Table S2. Synthesis parameters and optical properties of BCNO-Y, BCNO-W, BCNO-B and BCNO-P phosphors.

Phosphors	Weight ratio, (GO/Boron acid/Urea)	Highest treatment temperature in air (°C)	Powder color under solar light	Emission color excited at 365nm	Peak emission excited at 365nm (nm)	CIE coordinate excited at 365nm, (x,y)	Extenal quantum efficiency (EQE) (%)	First band gap (eV)	Second band gap (eV)
BCNO-Y	20/30/600	800	Light gray	Yellow Green	550	(0.348,0.408)	16.7	3.3 (375nm)	2.1 (590nm)
BCNO-B	10/30/600	800	White	Greenish Blue	438	(0.186,0.219)	27.1	4.3 (288nm)	2.3 (539nm)
BCNO-P	20/30/600	750	White	Purperlish Blue	388	(0.190,0.236)	45.9	4.9 (253nm)	3.7 (335nm)
BCNO-W	10/30/600	750	White	White	445	(0.292,0.342)	28.2	5.9 (210nm)	3.4(365nm)