Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Electronic Supplementary Information (ESI)

New emerging rare-earth free yellow emitting 2D BCNO nanophosphor for white light emitting diodes

Jaya Dwivedi,[a,b] Pawan Kumar,[a,b] Garima Kedawat[c] and Bipin Kumar Gupta[a,*]

[a]CSIR - National Physical Laboratory, Dr K S Krishnan Road, New Delhi, 110012, India

[b]Academy of Scientific and Innovative Research (AcSIR), CSIR – National Physical Laboratory, New Delhi – 110012, India

[c]Department of Physics, Kalindi College, University of Delhi, New Delhi, 110008, India

*Corresponding authors E-mail: bipinbhu@yahoo.com

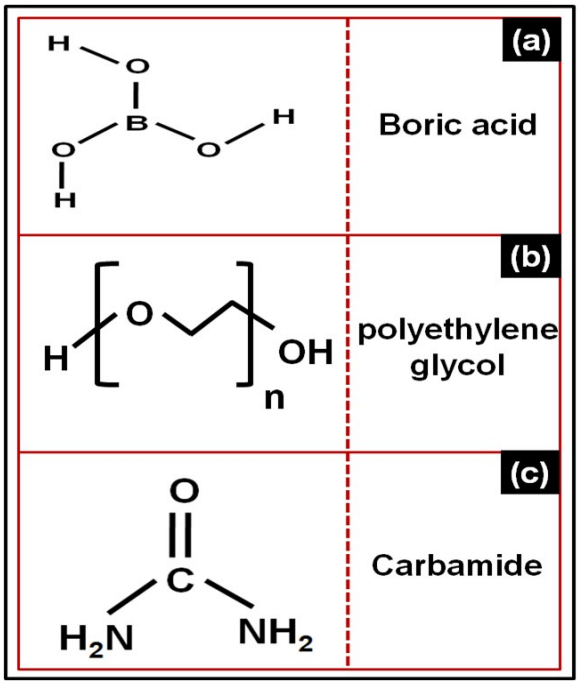


Fig. S1: Chemical structure of boric acid, polyethylene glycol and carbamide.

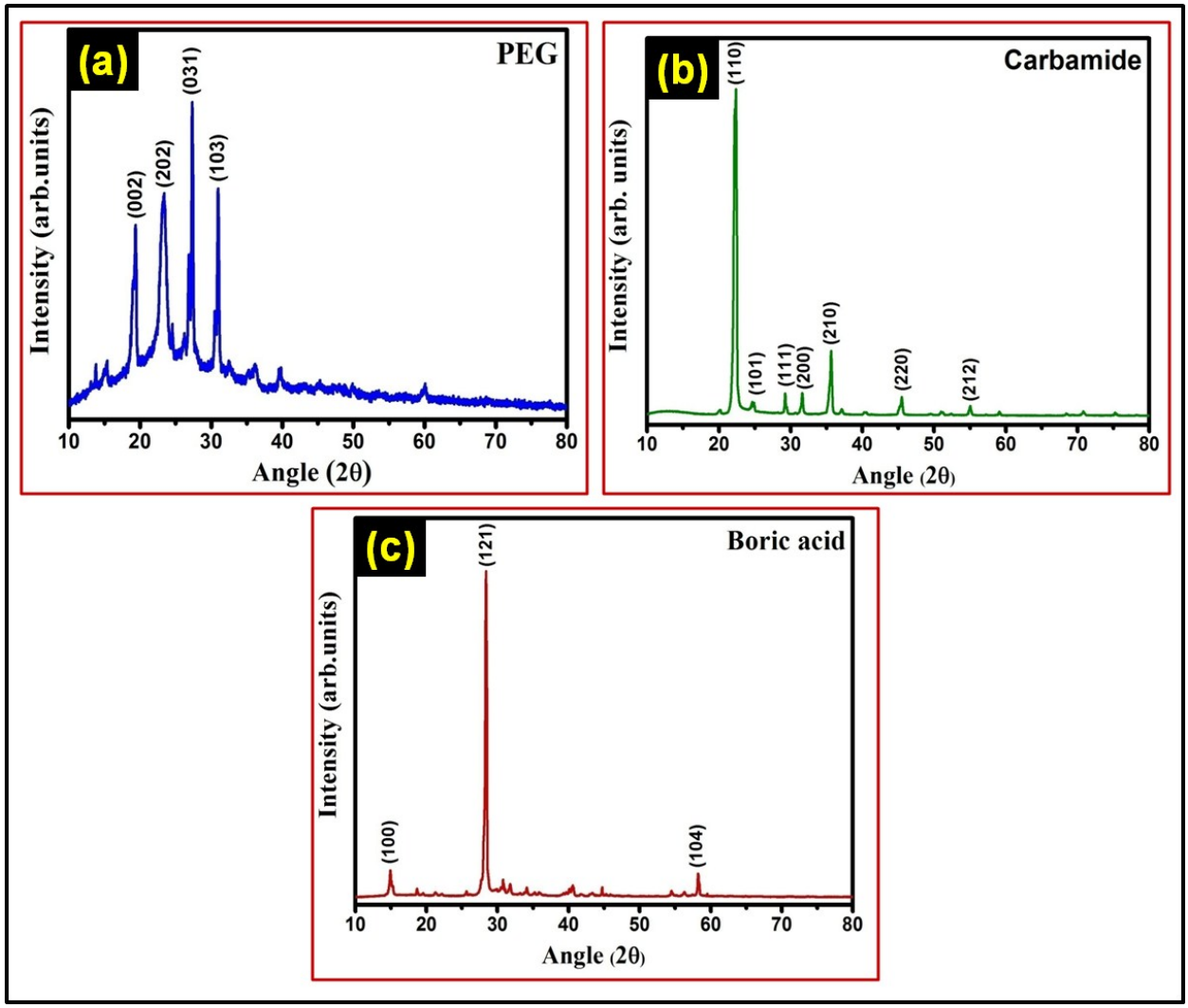


Fig. S2: (a-c) XRD patterns of PEG, carbamide and boric acid, which are indexed by JCPDS Card No. 45-0706, 86-2276 and 78-0459, respectively.

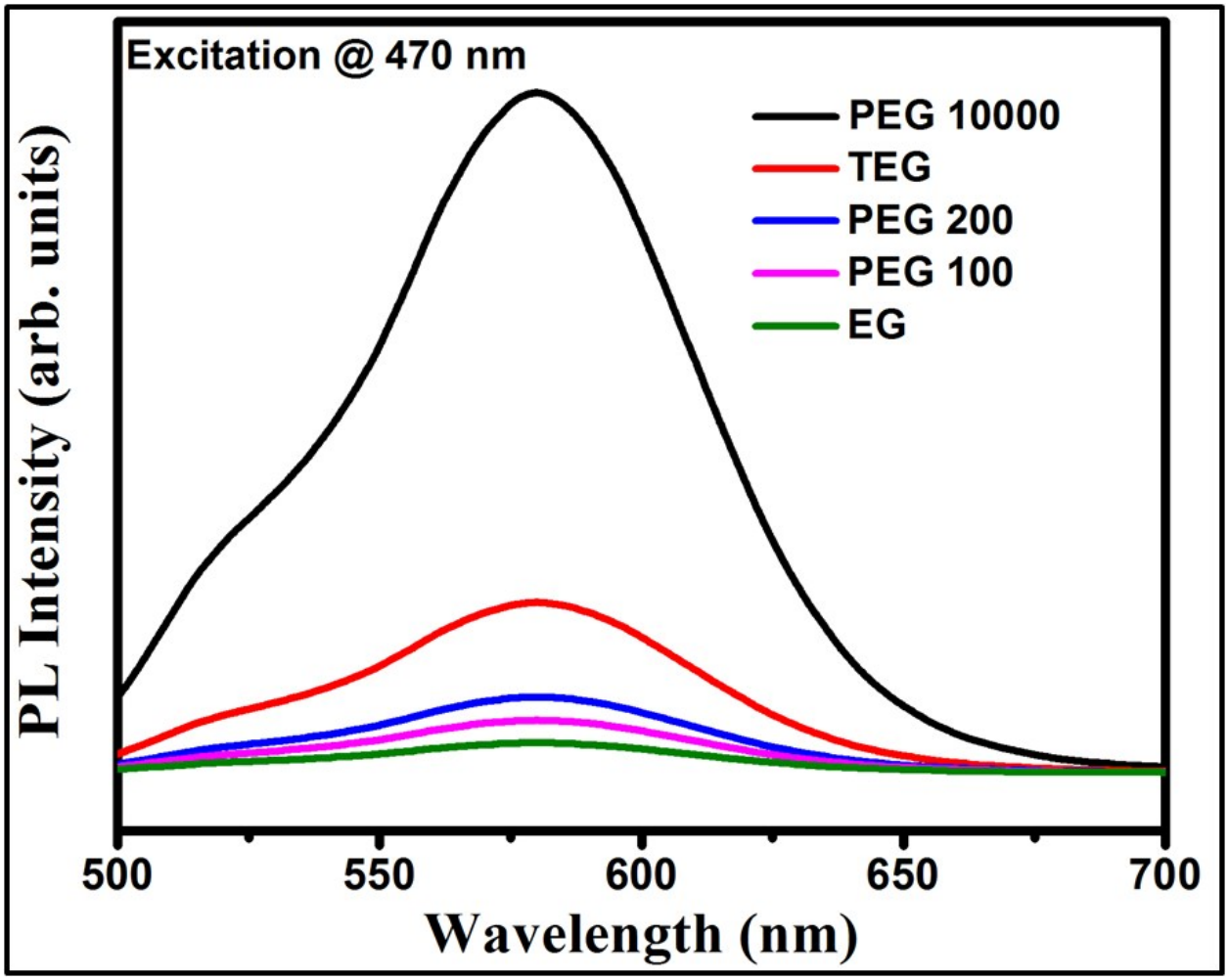
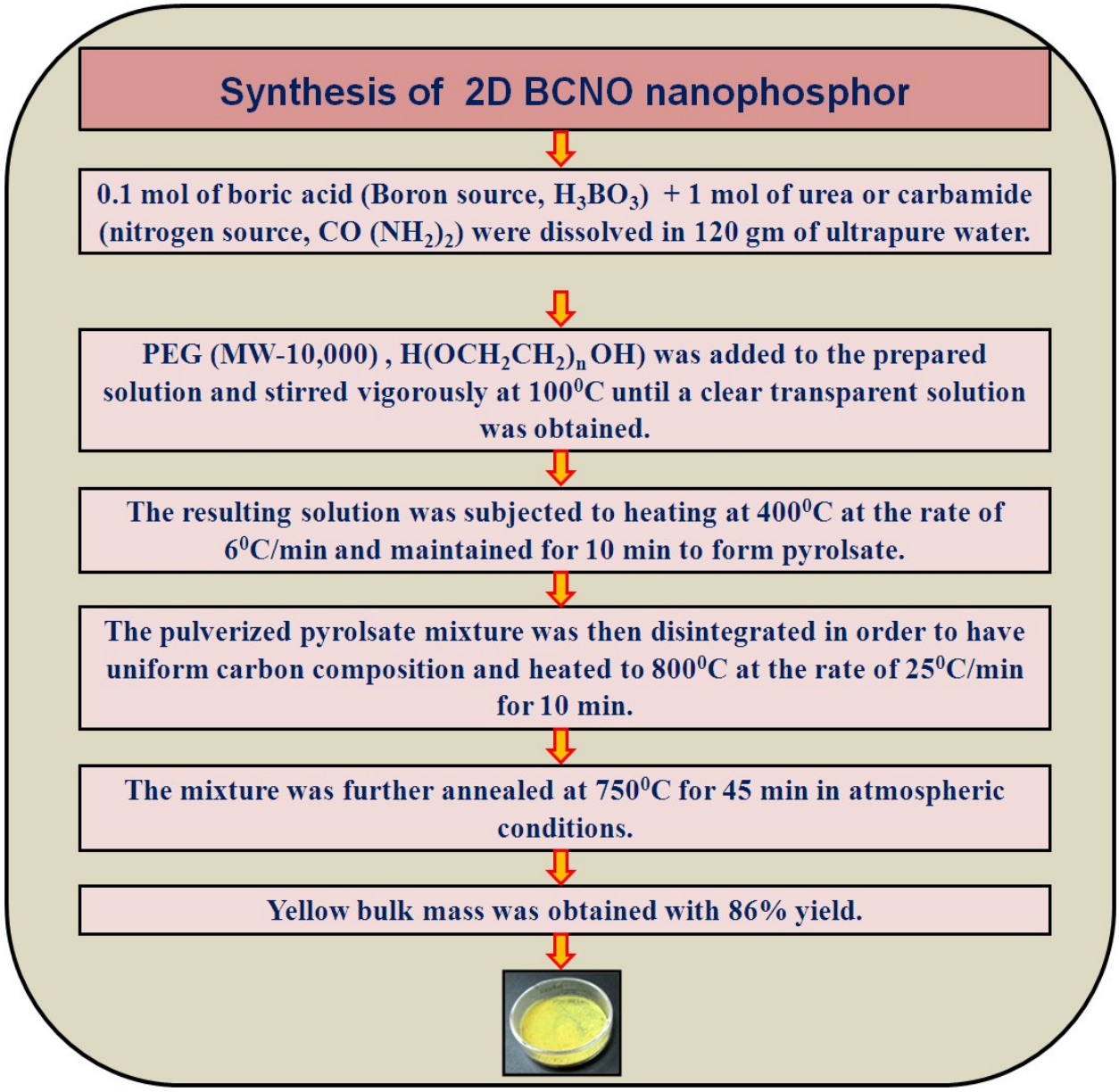
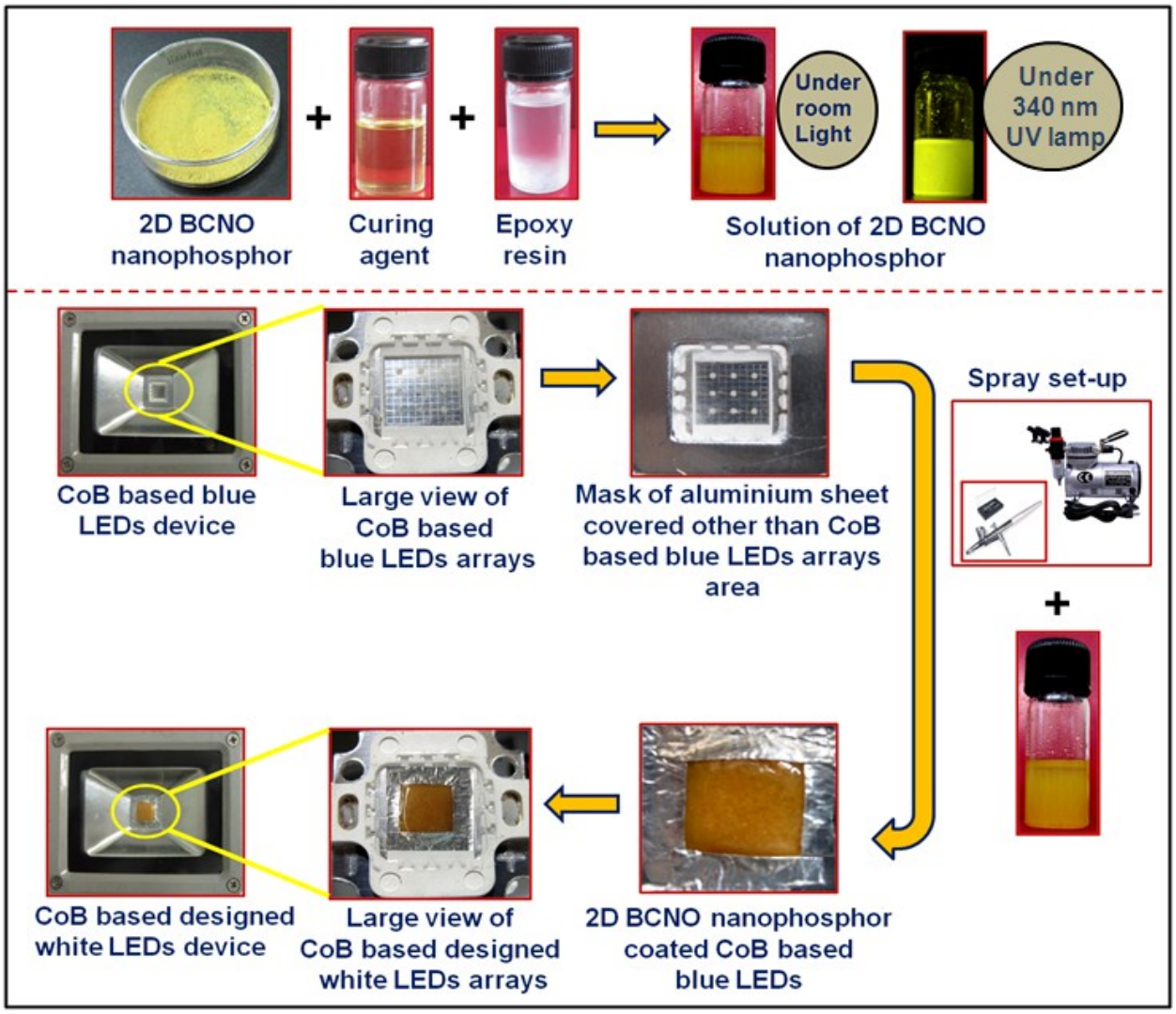


Fig. S3: PL spectra of various carbon sources for optimization of carbon source having higher PL intensity of 2D BCNO nanophosphor.



Scheme S1: Protocol for the synthesis of 2D BCNO nanophosphor by customized auto-combustion method.



Scheme S2: Systematic procedure of spary coating of 2D BCNO nanophosphor on CoB based blue LEDs.

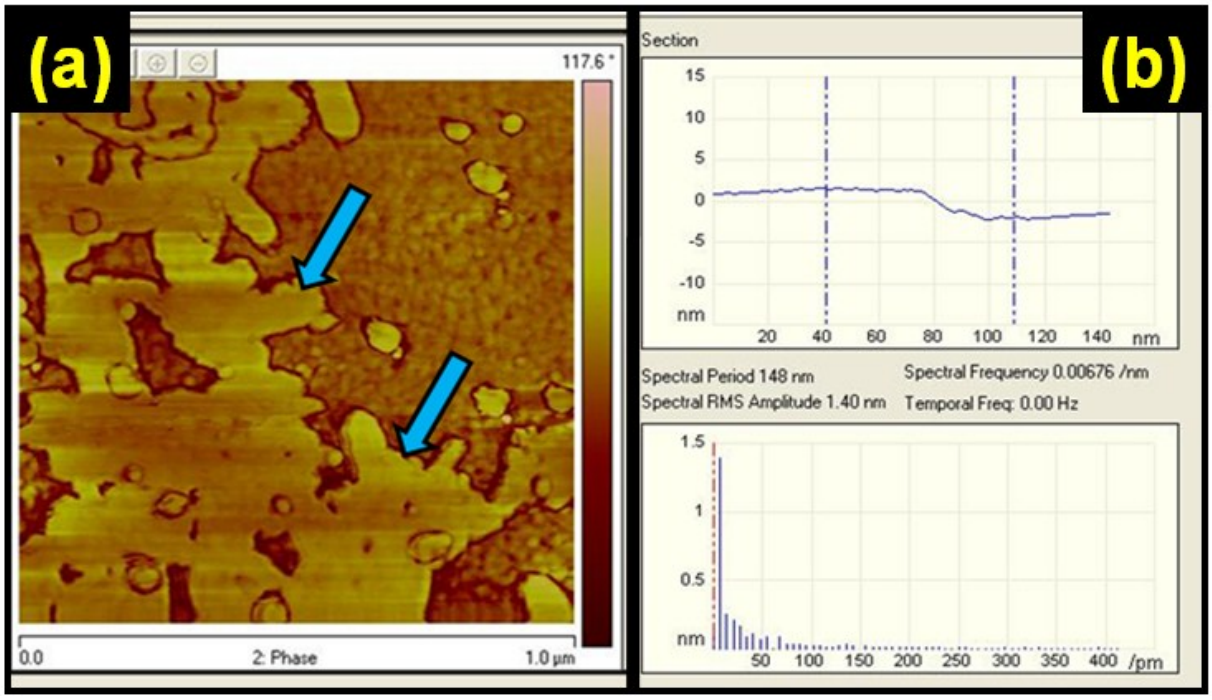


Fig. S4: (a) AFM micrograph of 2D BCNO nanophosphor and (b) its corresponding line-scan profile, it indicates a thickness of about 2 nm corresponding to the few BCNO layers; the region marked by blue arrow in Fig. S4a exhibits the place, where line-scan profile has been taken to calculate the thickness of layers.

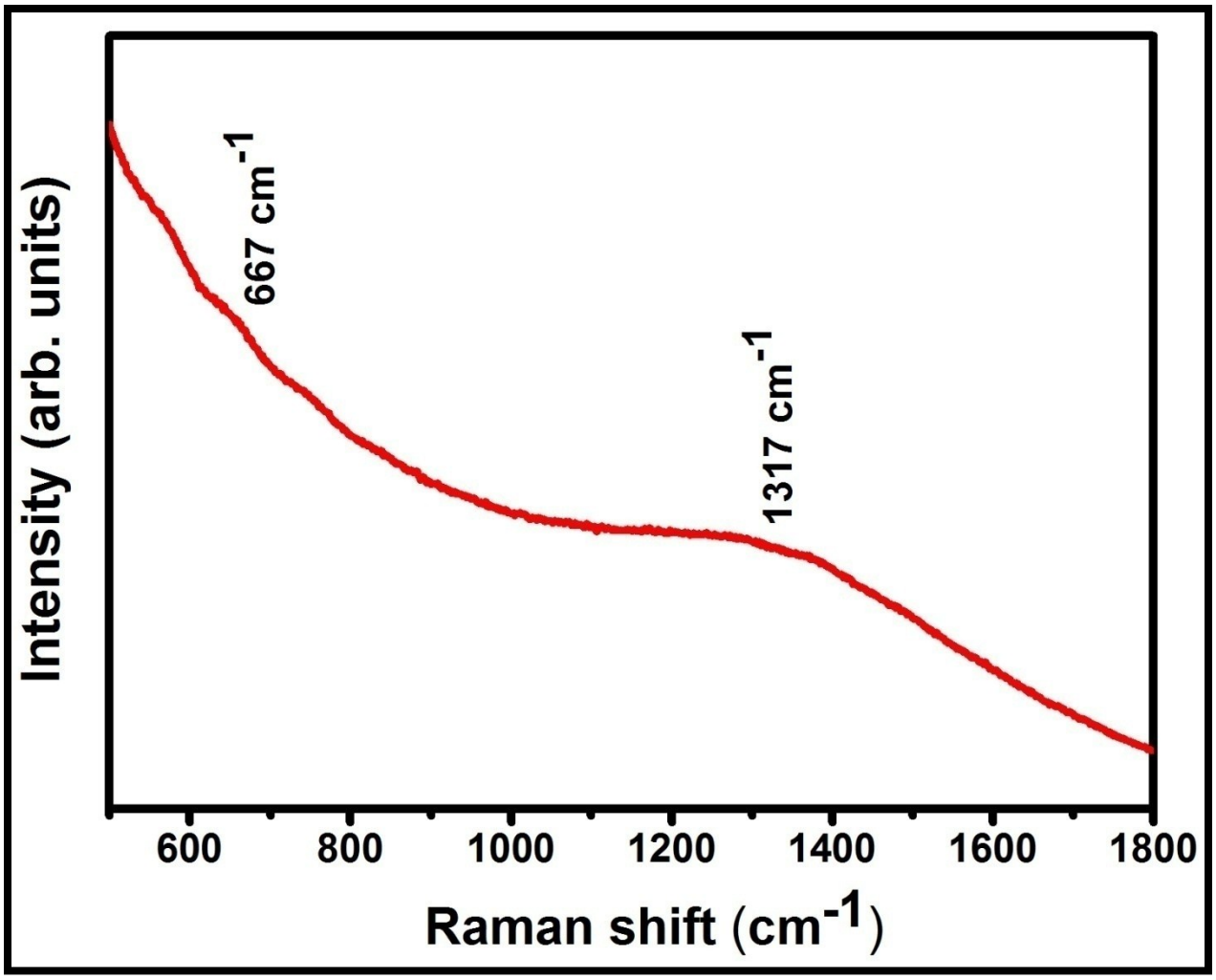


Fig. S5: (a) Raman spectrum of 2D BCNO nanophosphor.

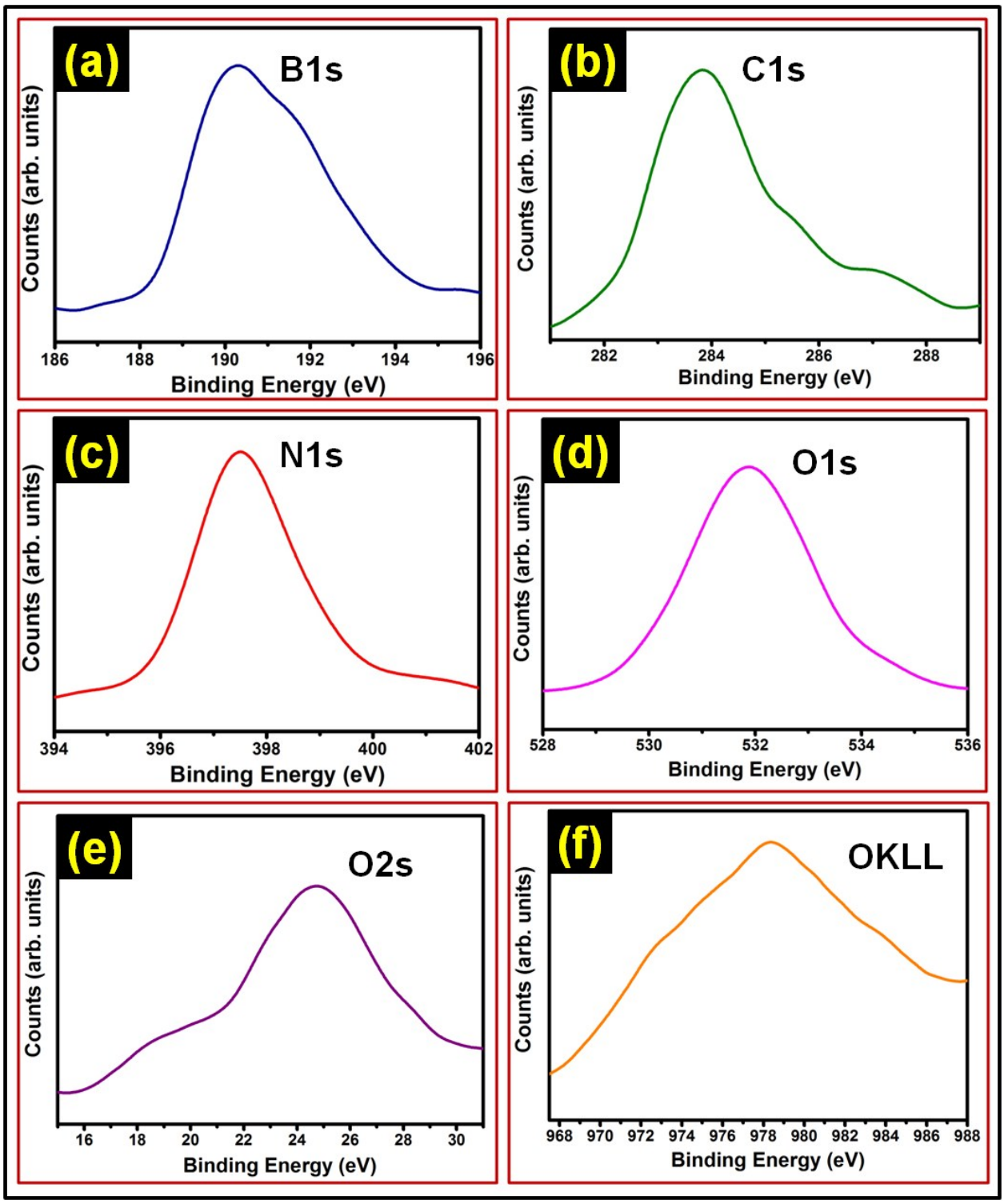


Fig. S6: (a-f) Core level XPS spectra of B1s, C1s, N1s, O1s, O2s and OKLL region for the 2D BCNO nanophosphor, respectively.

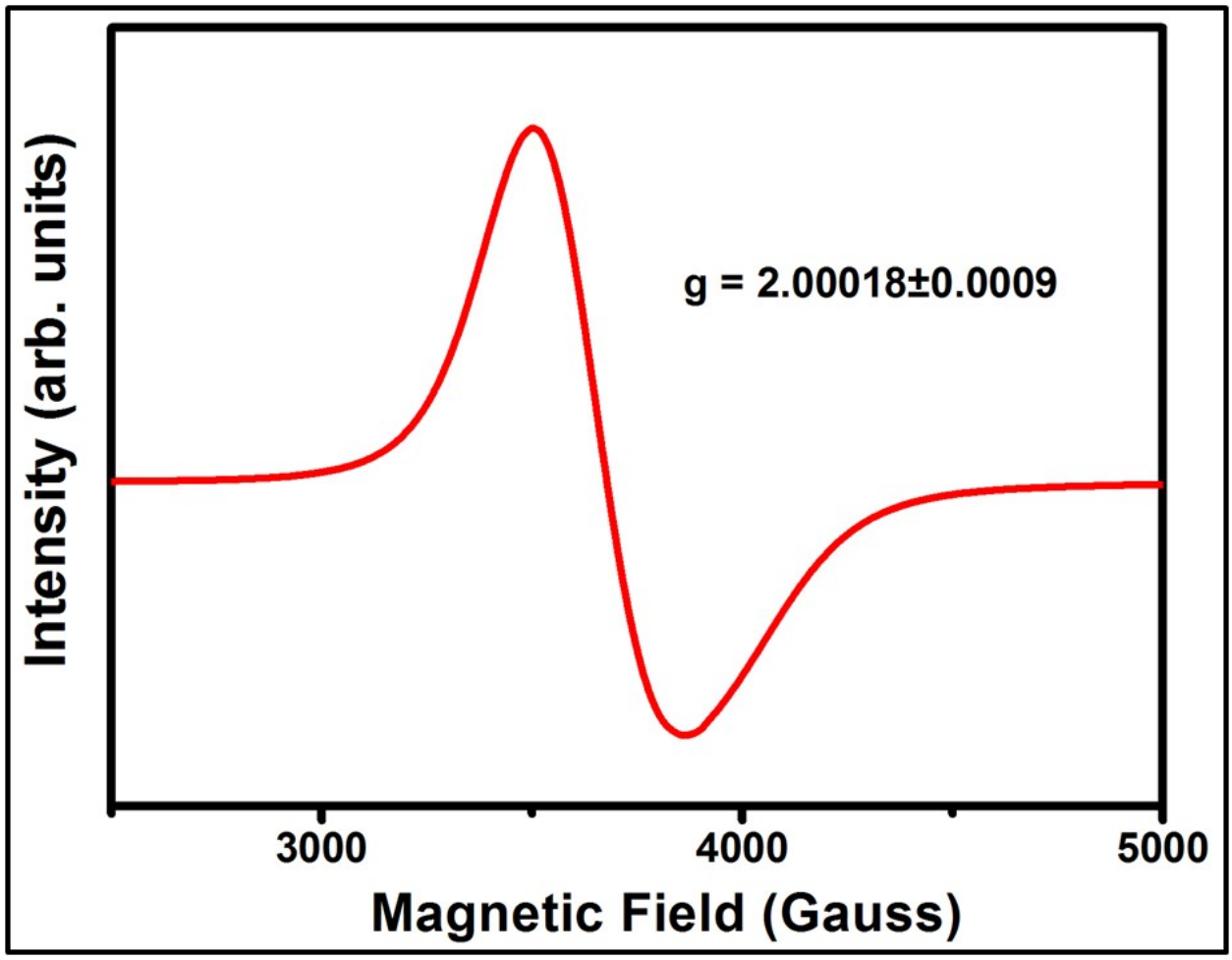


Fig. S7: EPR spectrum of 2D BCNO nanophosphor.

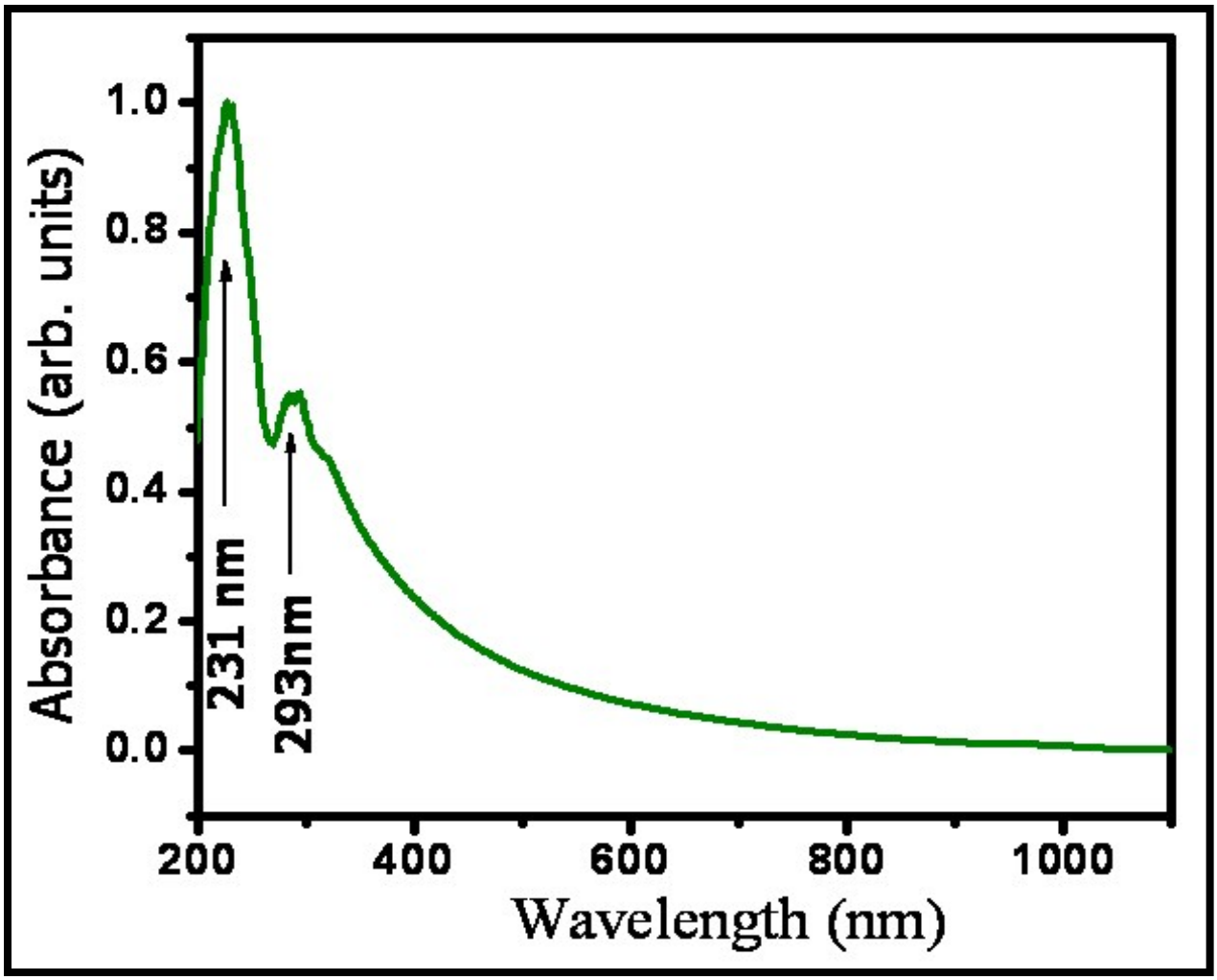


Fig. S8: UV-Vis absorption spectrum of 2D BCNO nanophosphor.

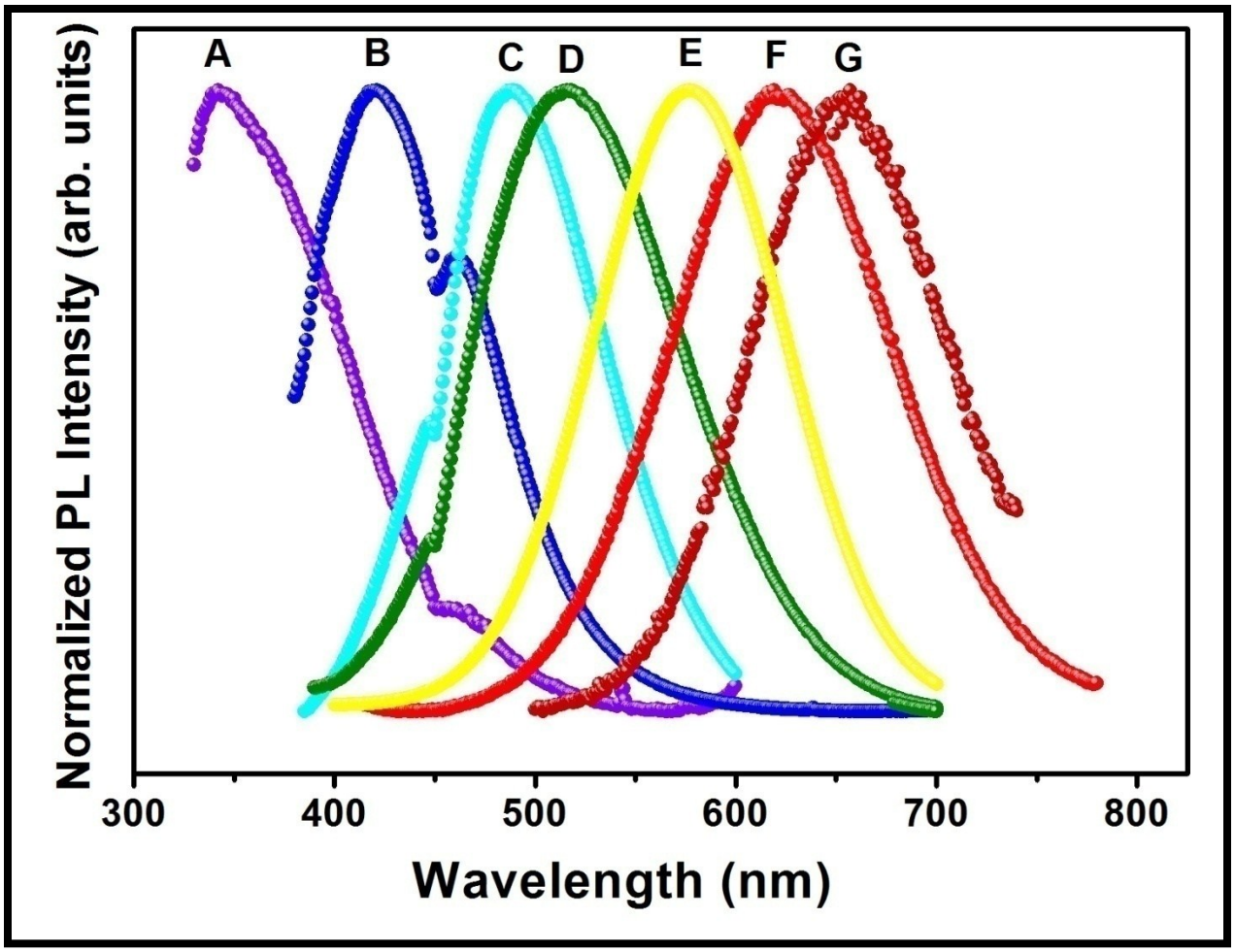


Fig. S9: PL spectra of 2D BCNO nanophophor with diferent concentration ratio of B/C, where A = 342 nm, B = 420 nm, C = 485 nm, D = 515 nm, E = 580 nm, F = 619 nm, G = 654 nm.

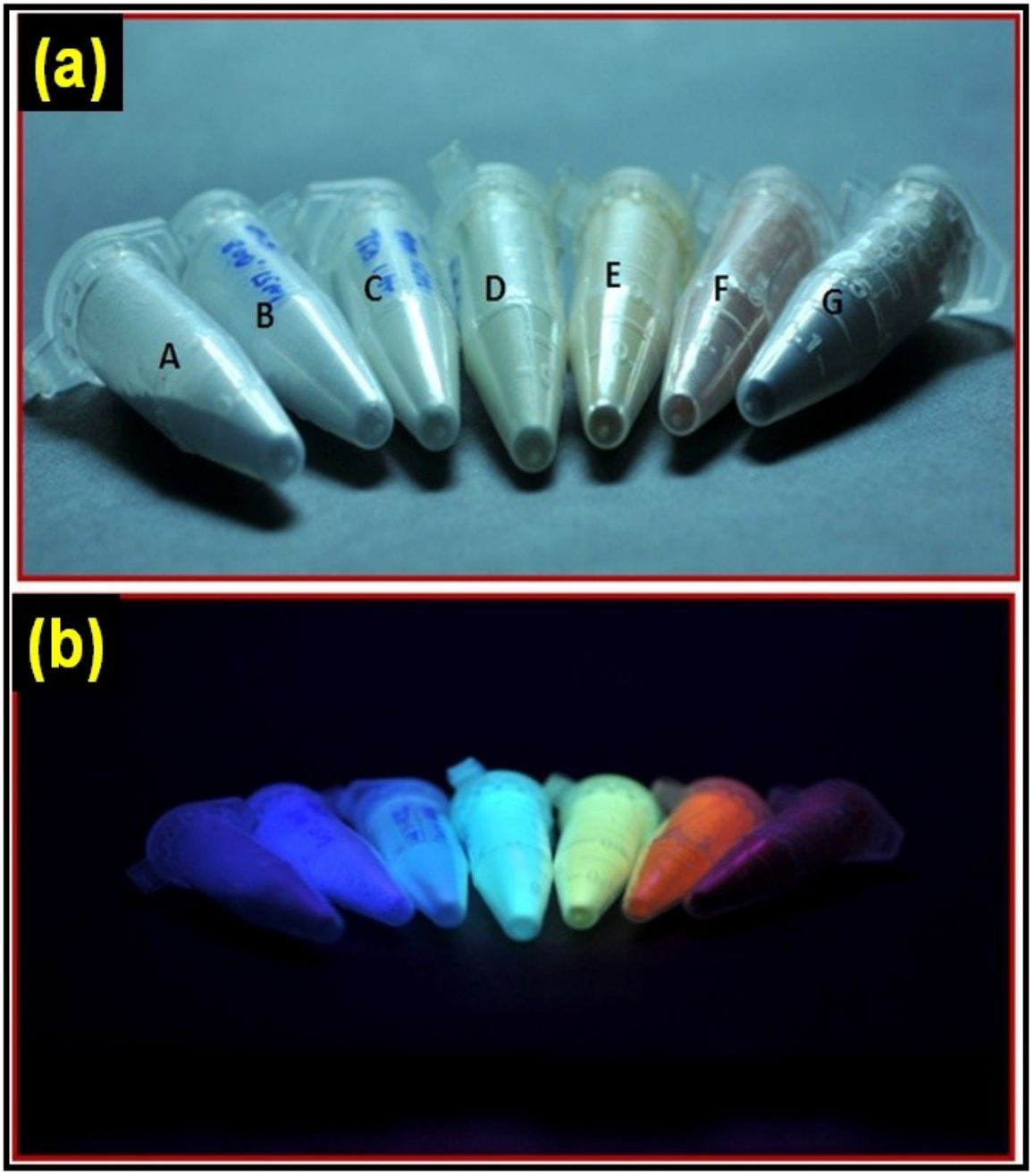


Fig. S10: Optical photograph of (a) 2D BCNO nanophosphor with diferent concentration ratio of B/C in powder form (b) same phsophors under 340 nm excitation UV lamp.

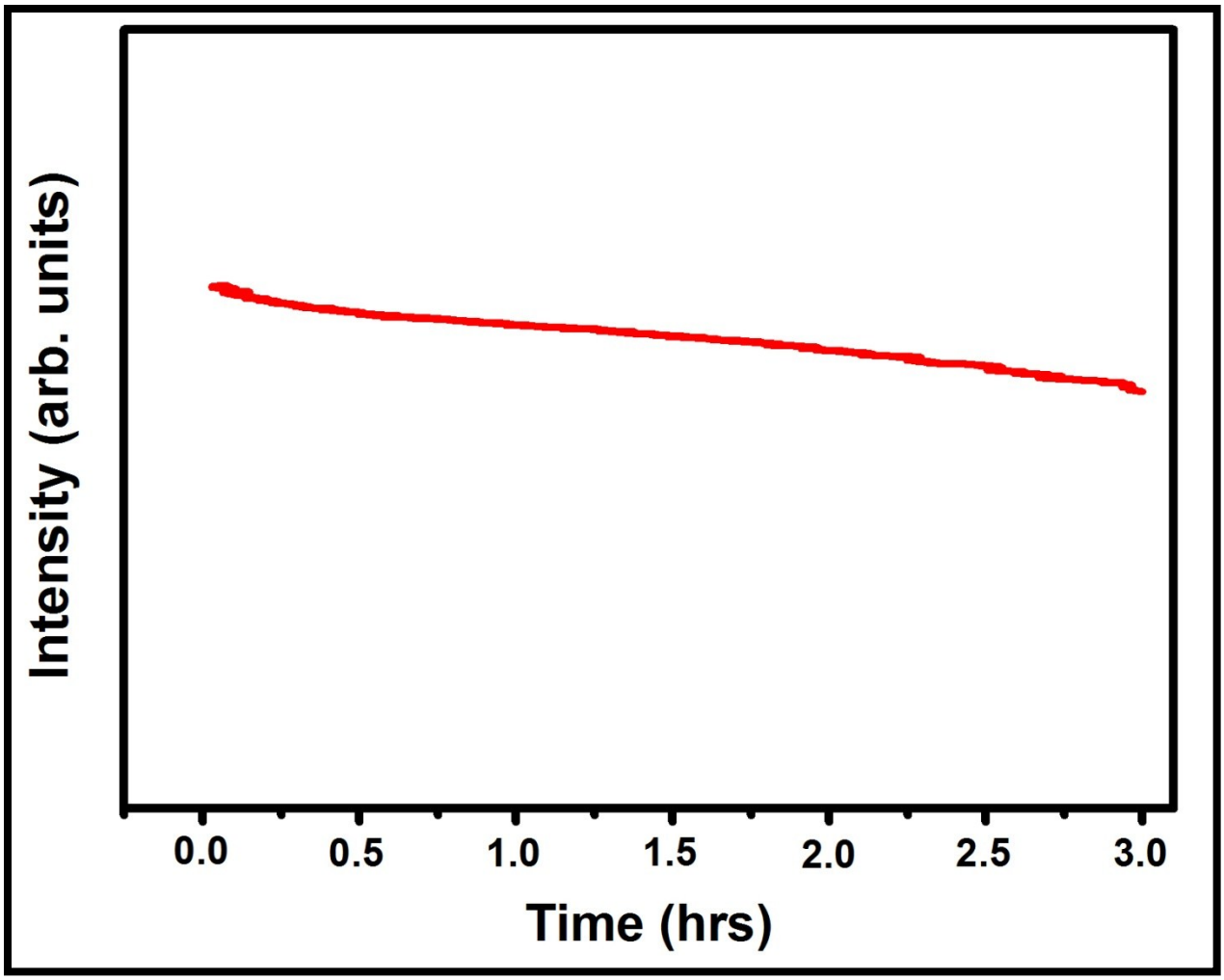


Fig. S11: Photo bleaching spectrum of 2D BCNO nanophosphor.

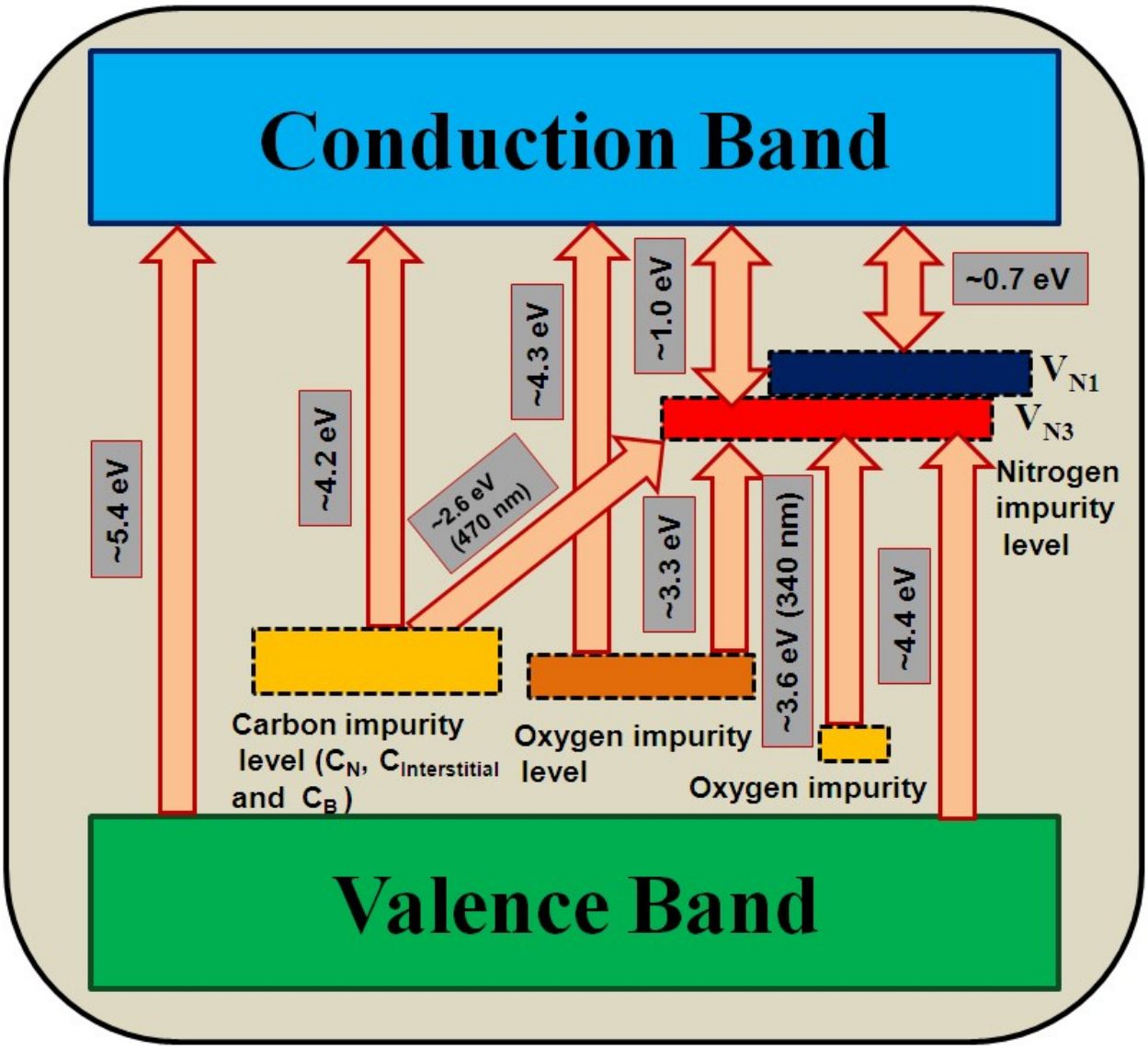


Fig. S12: Proposed energy level diagram of 2D BCNO nanophosphor based on earlier reported in literature.[1]

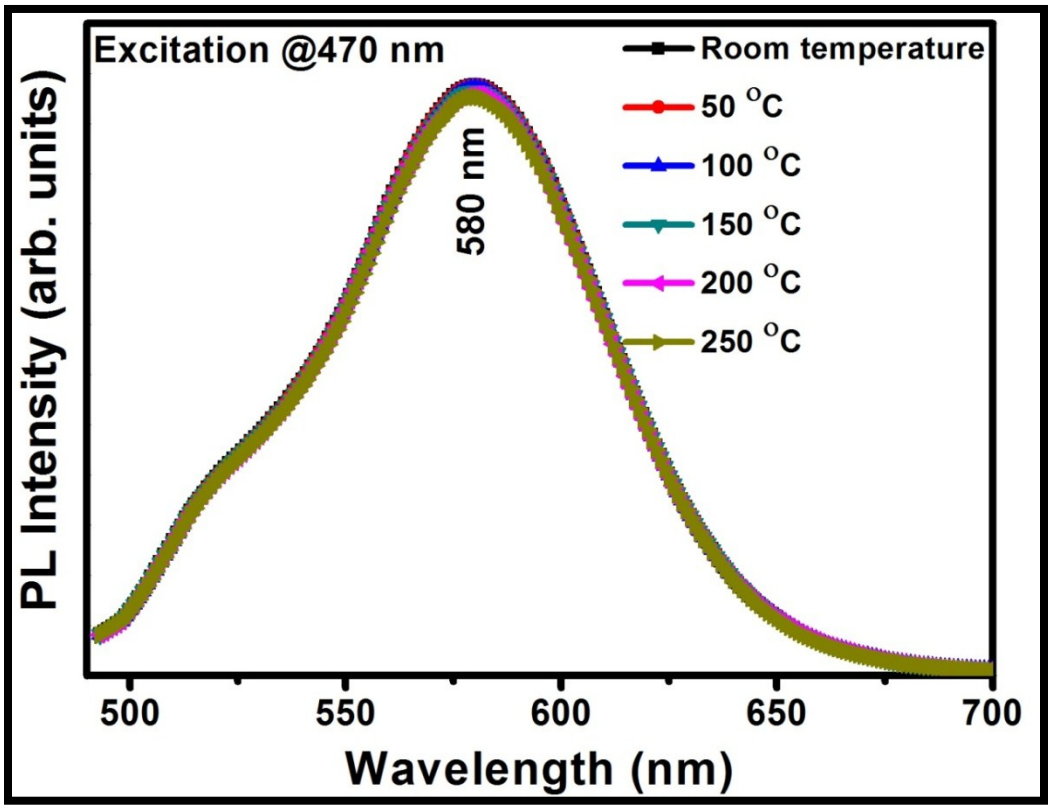


Fig. S13: PL emission spectra of 2D BCNO nanophosphor at different temperature under 470 nm excitation wavelength.

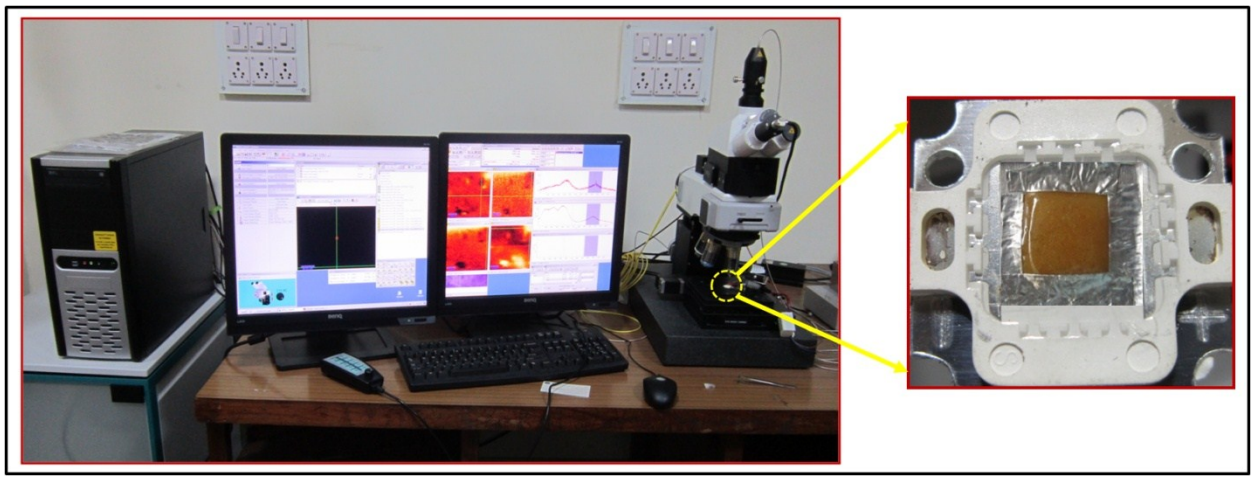


Fig. S14: Confocal microscope during the process of PL mapping of 2D BCNO nanophosphor coated CoB based blue LEDs.

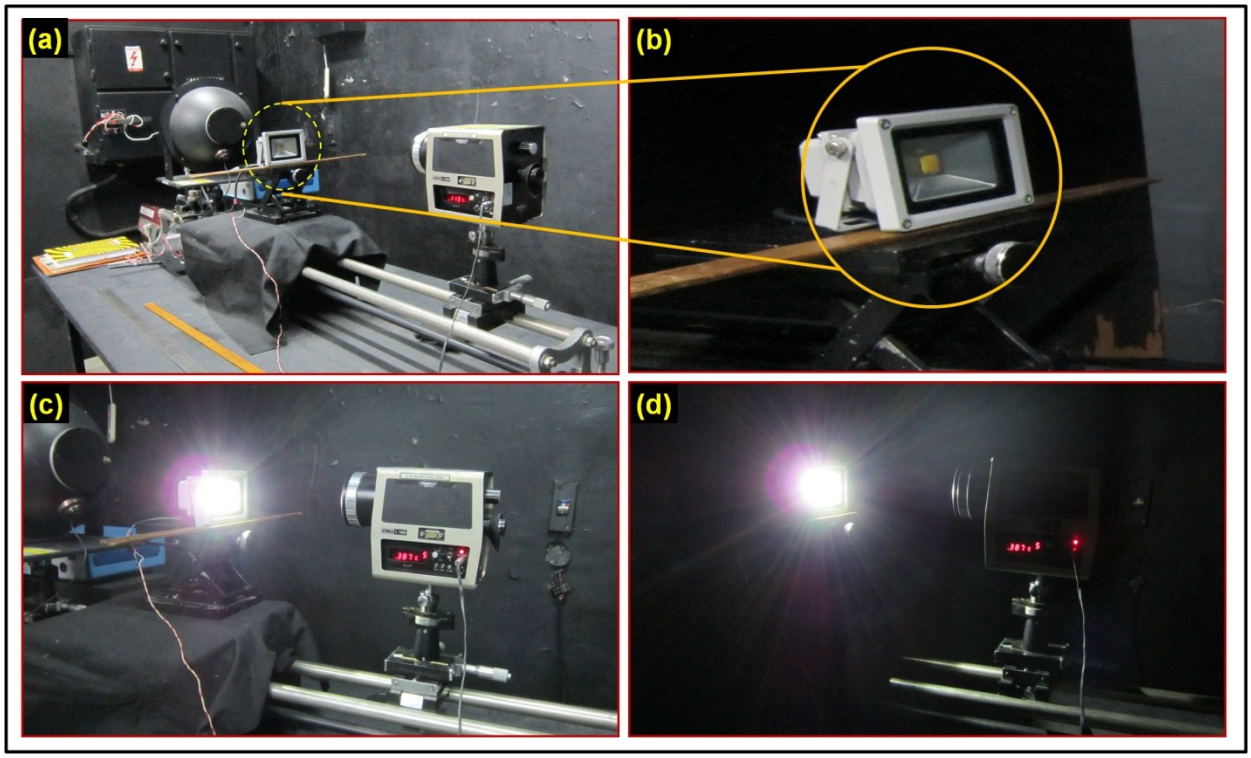


Fig. S15: Electroluminescence measurement instrument along with BCNO phosphor coated CoB based blue LEDs.

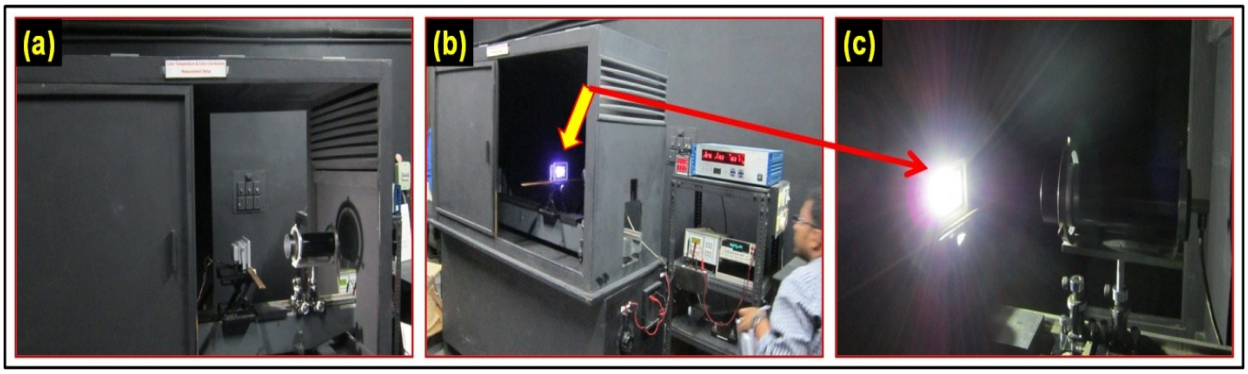


Fig. S16: Color temperature and CIE color co-ordinates measurement instrument (Colorimeter, C1210, serial no. 1296104) (facility at NPL, New Delhi, India) set-up.

Table T1: Summary of color emission at different ratios of B/C in BCNO layered materials, where B/N ratio was kept constant.

Sample Name	B/N mol ratio	B/C mmol ratio	Emission Wavelength	Excitation Wavelength	Emission Wavelength	Quantum Efficiency
A	0.025/0.25	25/0	Violet	315 nm	342 nm	38%
B	0.025/0.25	25/0.05	Blue	370 nm	420 nm	45%
C	0.025/0.25	25/0.1	Sky blue	385 nm	485 nm	60%
D	0.025/0.25	25/0.15	Green	415 nm	515 nm	70%
E	0.025/0.25	25/0.2	Yellow	470 nm	580 nm	89%
F	0.025/0.25	25/0.2.5	Red	485 nm	619 nm	63%
G	0.025/0.25	25/0.3	Deep red	510 nm	654 nm	21%

Table T2: Brightness of the 2D BCNO yellow nanophosphor coated CoB based blue LEDs device at different time interval

Time duration (hours)	Brightness (Cd/m^2)
1	834±5
2	831±5
5	833±5
10	832±5

References

1 X. Zhang, L. Li, Z. Lu, J. Lin, X. Xu, Y. Ma, X. Yang, F. Meng, J. Zhao and C. Tang , *J. Am. Ceram. Soc.*, 2014, **97**, 246-250.