Electronic Supplementary Material (ESI) for Materials Advances.

Supporting Information

Urea-Assisted Synthesis of Carbon-Doped $BiNbO_4$ with Oxygen Vacancies and Visible Light Photocatalytic Applications

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SI1. Micro-Raman spectra of $BiNbO_4$ and U-$BiNbO_4$.

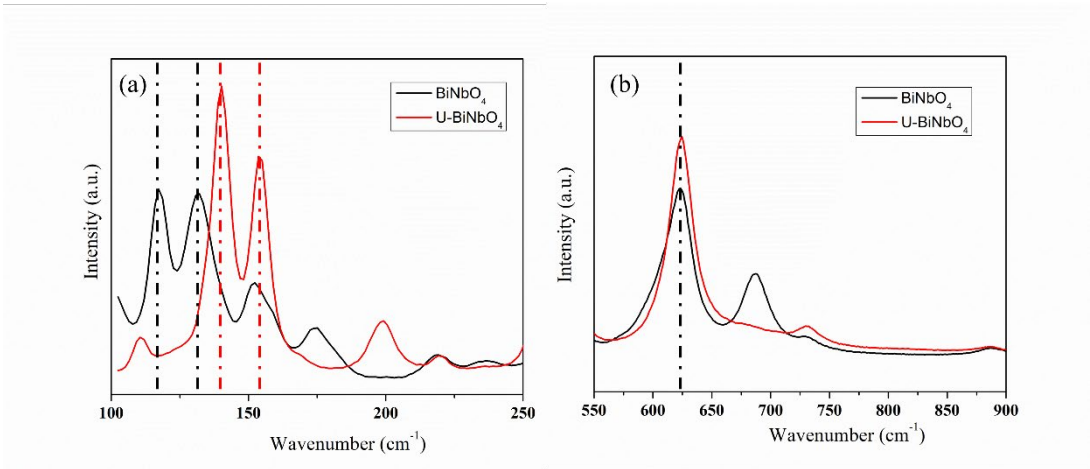

Figure S1. Raman spectra in the (a) 100 – 250 cm-1 and (b) 550 – 900 cm-1 regions for pristine $BiNbO_4$ and U-$BiNbO_4$.

SI2. XPS spectrum of Bi4f and Nb3d for pristine $BiNbO_4$ (panels A, C) and U-$BiNbO_4$ (panels B, D), respectively.

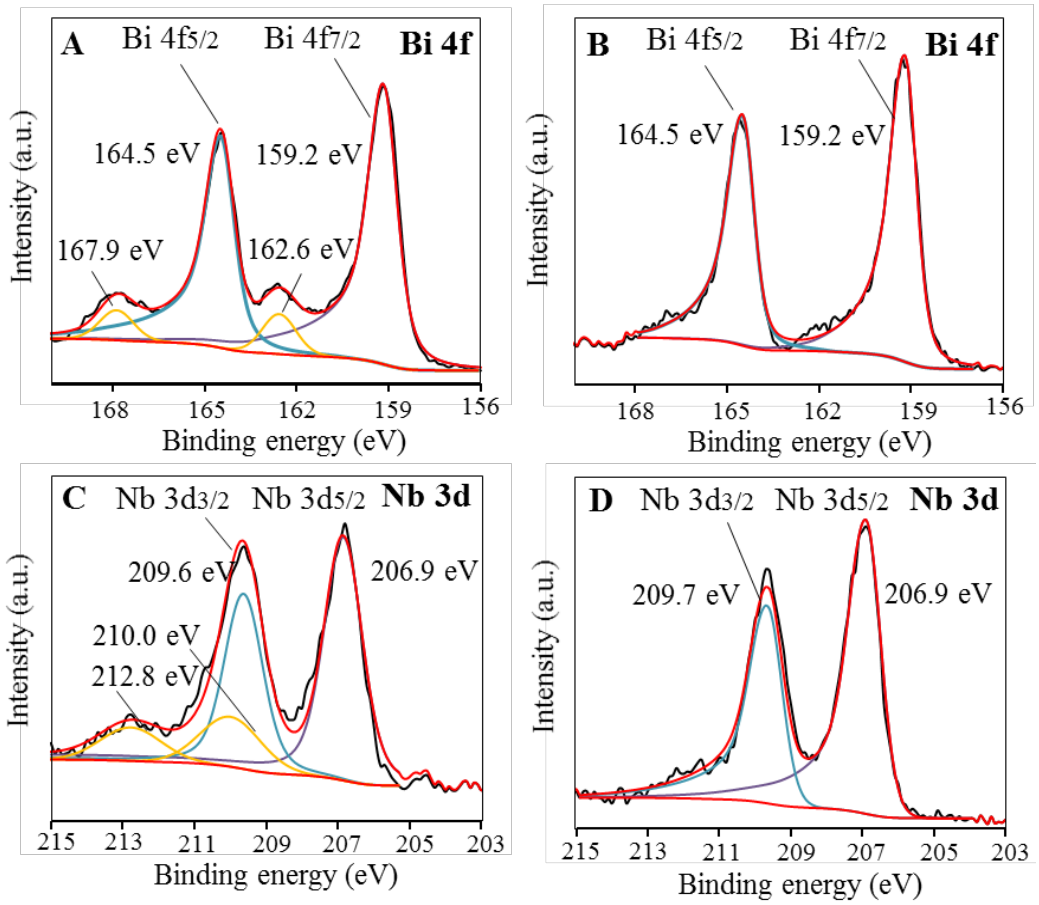

Figure S2. XPS spectra of Bi4f and Nb3d for pristine $BiNbO_4$ (panels A, C) and U-$BiNbO_4$ (panels B, D), respectively

The Bi4f spectrum of pristine BiNbO4 suggest the presence of Bi3+ (with main peaks at 159.2 eV and 164.5 eV, respectively), while the Bi4f spectrum of U-$BiNbO_4$ also consist of Bi(+3) only (with more predominate peaks at 159.2 eV and 164.5 eV, respectively [1]. The Nb3d spectrum of pristine $BiNbO_4$ also propose the presence of two chemical states of Nb(4+) (206.9 eV and 209.6 eV, respectively) and Nb(+5) (210.0 eV and 212.8 eV, respectively), while the U-BiNbO4 has only Nb(+4) on the surface[2]. Reduced amounts of oxygen at Bi4f and Nb3d chemical states for U-$BiNbO_4$ catalyst is another evidence of the enhanced presence of surface oxygen vacancies. No traces of nitrogen were detected in both samples.

SI3. EDS mapping images and spectrum of $BiNbO_4$ (panels (A) and (C)) and U-$BiNbO_4$ (panels (B) and (D)), respectively.

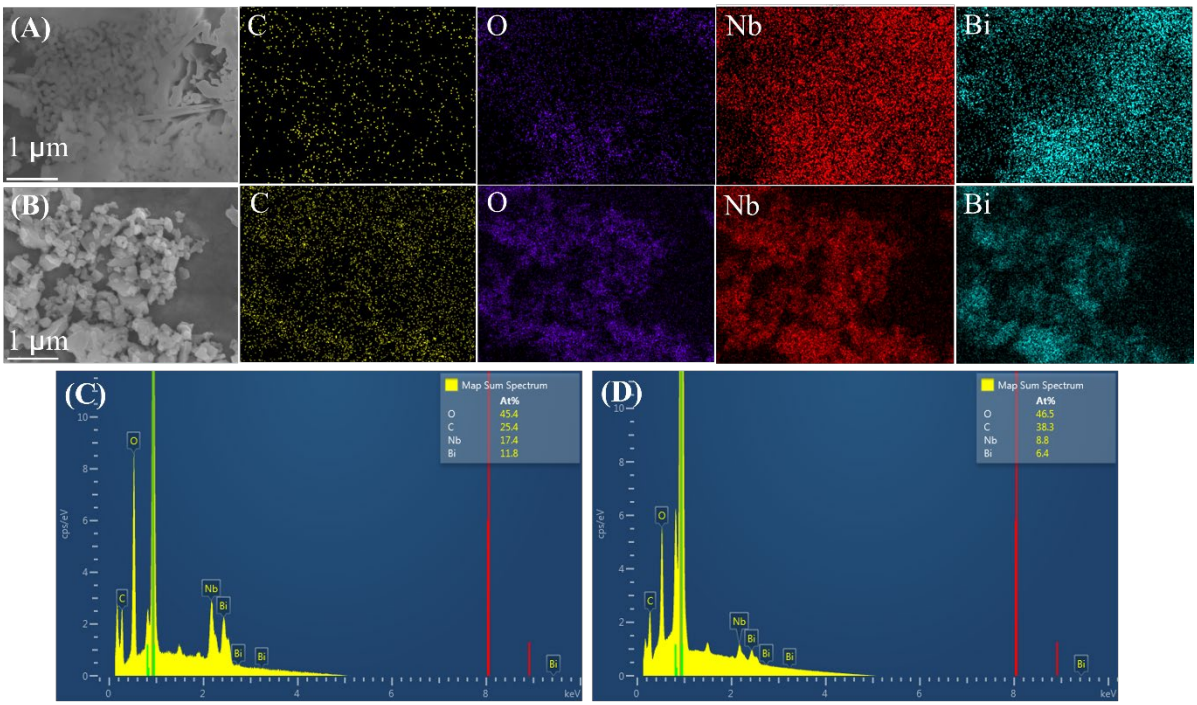

Figure S3. EDS mapping and spectral images for pristine $BiNbO_4$ (panels A and C) and U-$BiNbO_4$ (panels B and D); EDS spectra taken on Cu substrate indicated by green lines.

SI4. CHNS (Carbon, Hydrogen, Nitrogen and Sulphur) Elemental Analysis

CHNS elemental analysis was carried out using FLASH EA 1112 Series, CHNS-O Analyzer. Furnace temp is at 950 0C, testing time is 720 sec per sample. The weight percentage of C for $BiNbO_4$ and U-$BiNbO_4$ is 0.0385 % and 0.1077 %, respectively.

Table S1. Percentage of C and H.

Sample	C (wt%)	H(wt%)
BiNbO4	0.0385	0.0763
U-BiNbO4	0.1077	0.0865

SI5. Overall XPS survey spectra of U-BiNbO$_4$

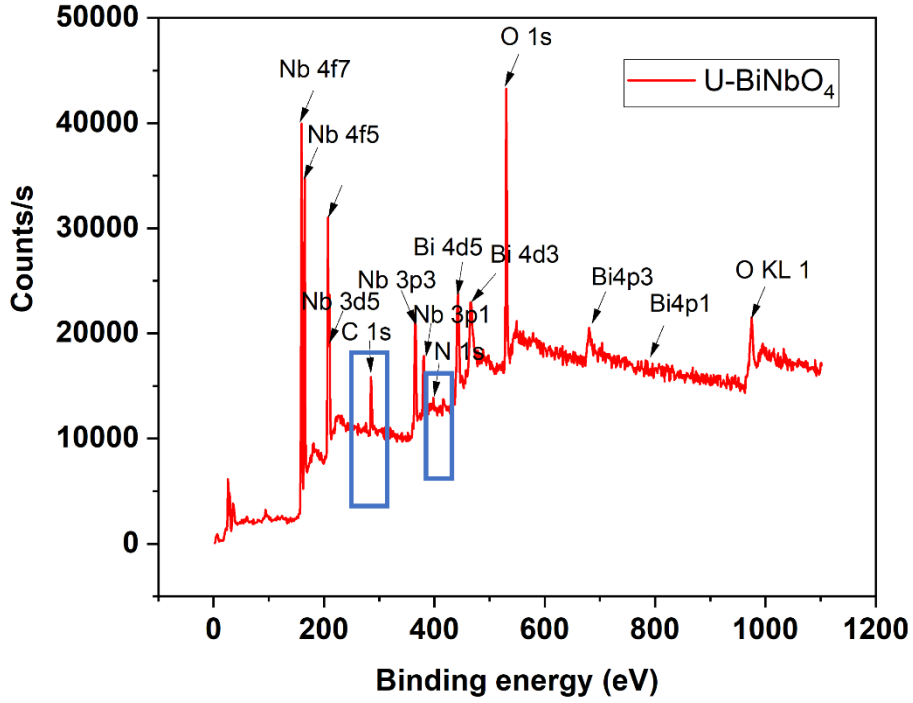

Figure S4: XPS survey spectra of U-BiNbO$_4$

SI6. Characteristic absorption bands of cationic A) MB and B) BG dyes for U-BiNbO$_4$ catalyst

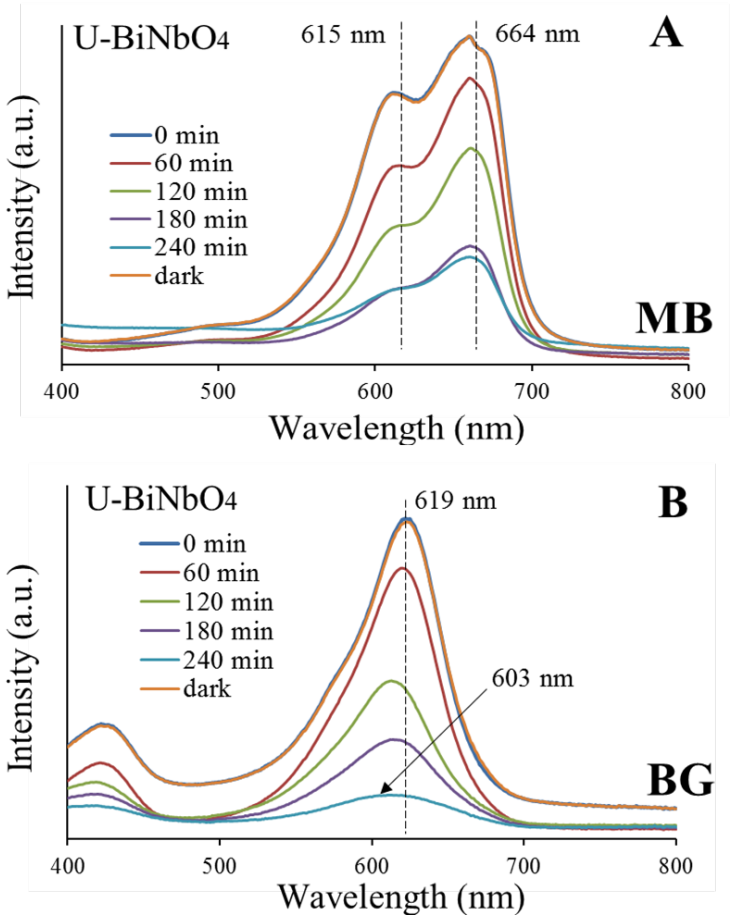

Figure S5: Characteristic absorption bands of cationic A) MB and B) BG dyes for U-BiNbO$_4$ catalyst.

SI7. Normalized photocatalytic degradation using 10, 15, 30, and 45 mg of U-$BiNbO_4$ for A) MB and B) BG dyes.

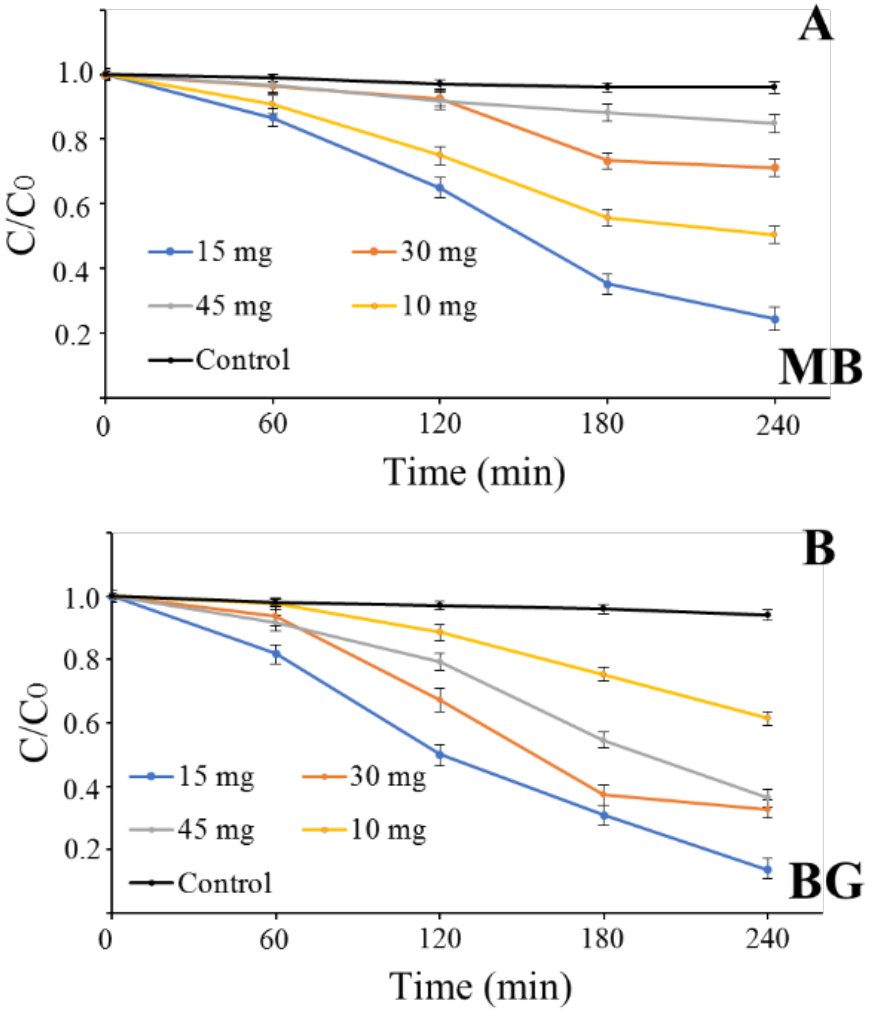

Figure S6: Photocatalytic degradation using 10, 15, 30, and 45 mg of U-$BiNbO_4$ for A) MB and B) BG dyes.

SI8. Normalized photocatalytic degradation of MB in different pH using U-$BiNbO_4$

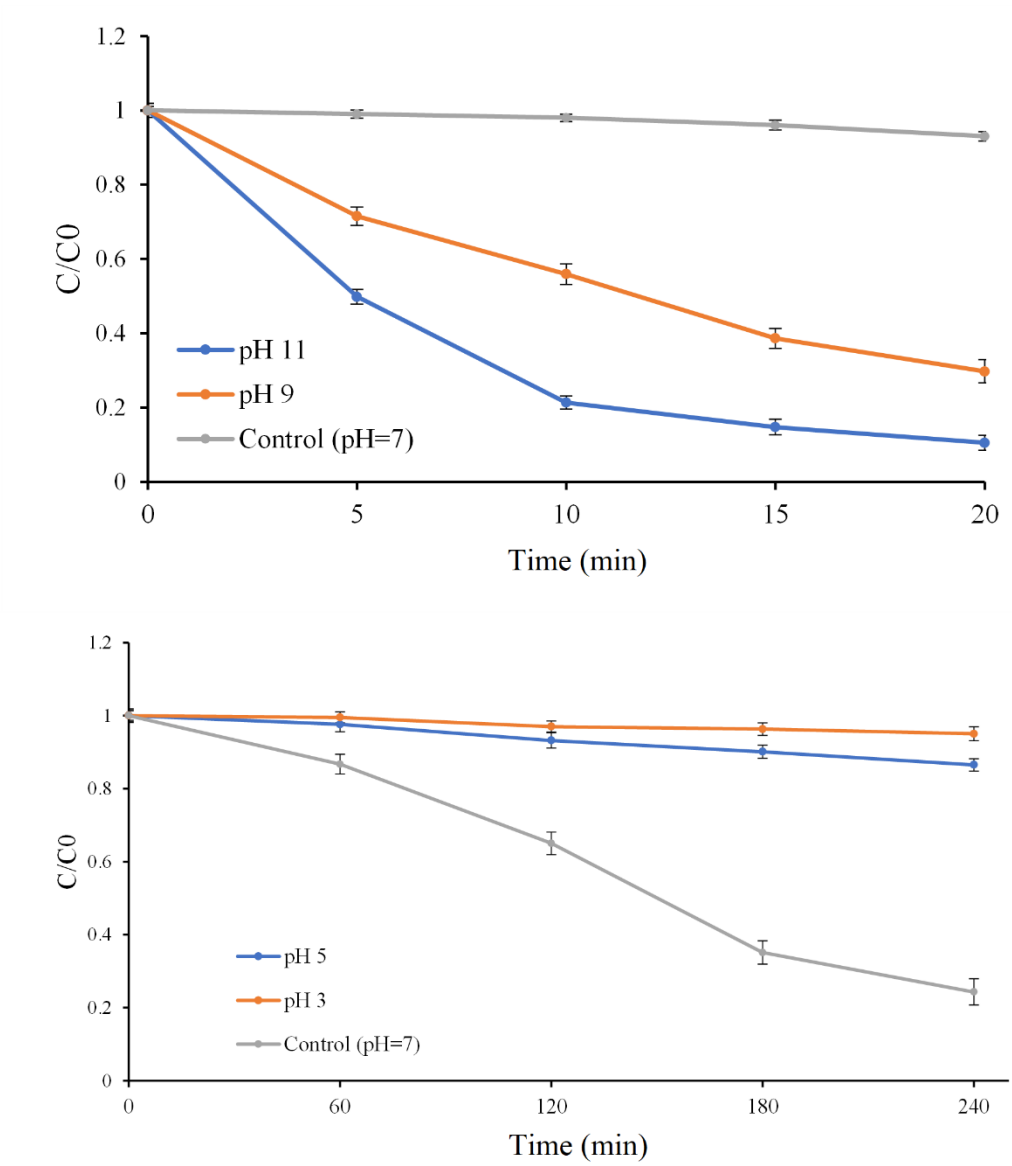

Figure S7: Photocatalytic degradation using pH 11.5,9.5,5.5 and 3.5 solutions of U-$BiNbO_4$ for MB.

References

1. M. Aslam, M. T. Soomro, I. M. I. Ismail, H. A. Qari, M. A. Gondal and A. Hameed, *RSC Advances*, 2015, **5**, 102663-102673.
2. K. Senevirathne, R. Hui, S. Campbell, S. Ye and J. Zhang, *Electrochimica Acta*, 2012, **59**, 538-547.