

## Supporting Information

### Highly Efficient and Robust Multi-Color Afterglow of ZnO nanoparticles

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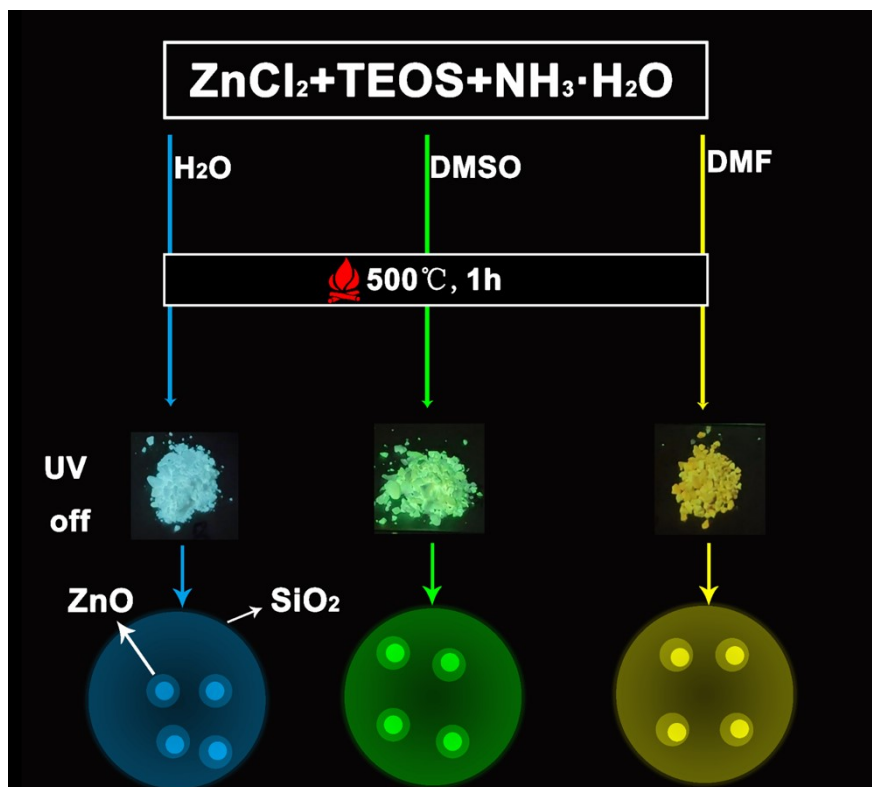
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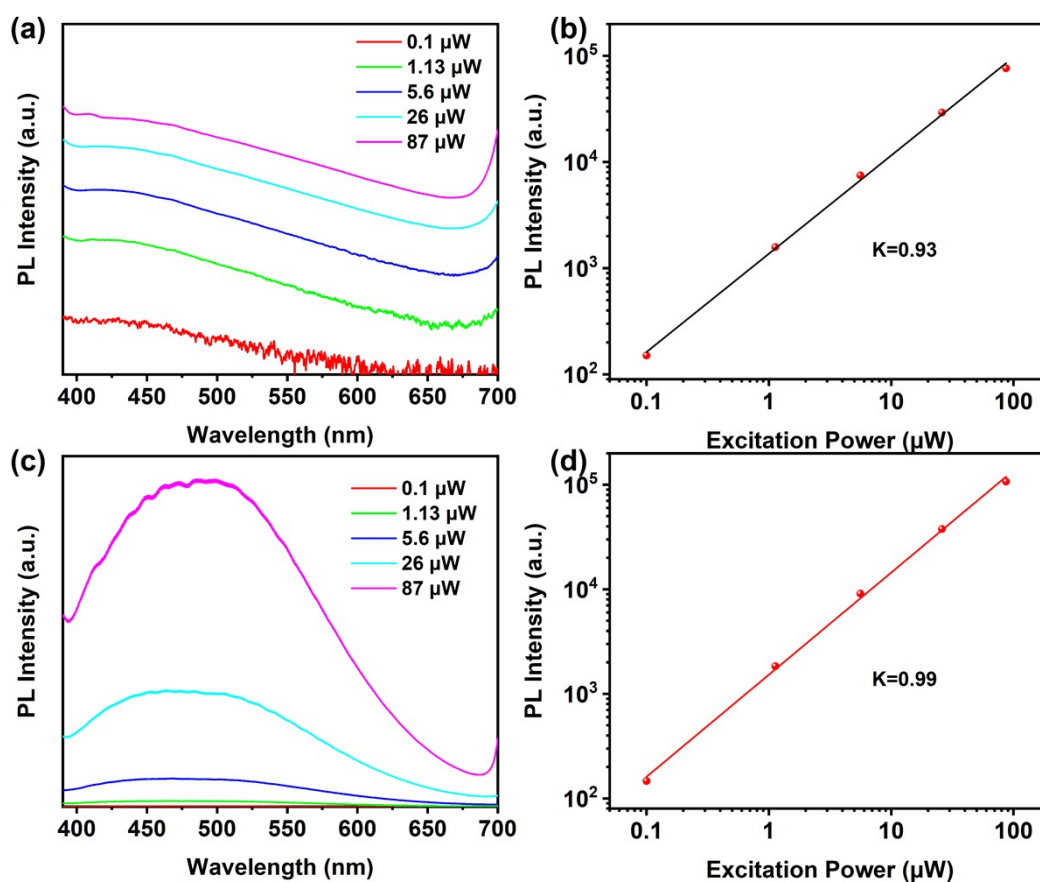
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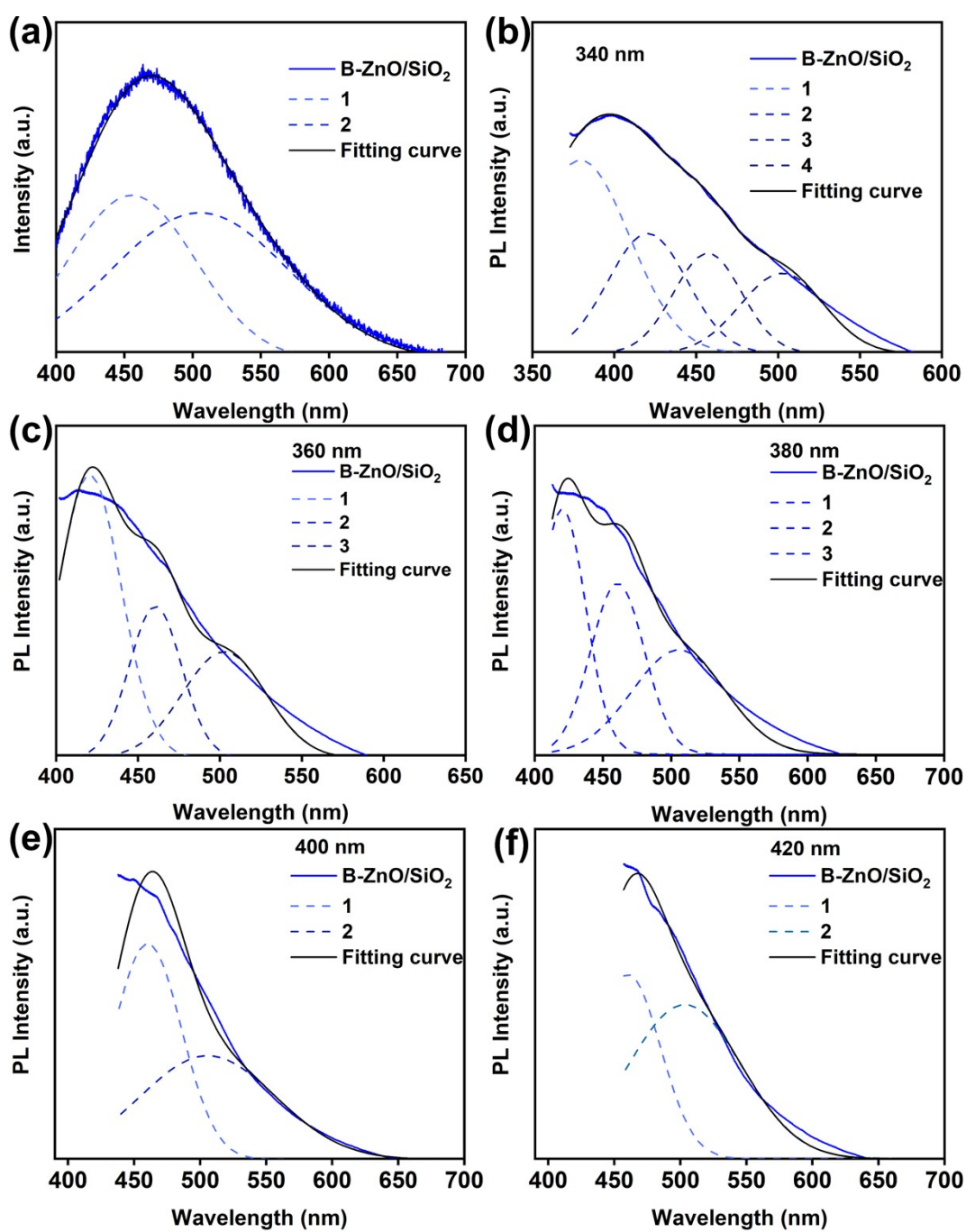
Email: [cs@hebut.edu.cn](mailto:cs@hebut.edu.cn) and [liuxiaohui@bttc.edu.cn](mailto:liuxiaohui@bttc.edu.cn)



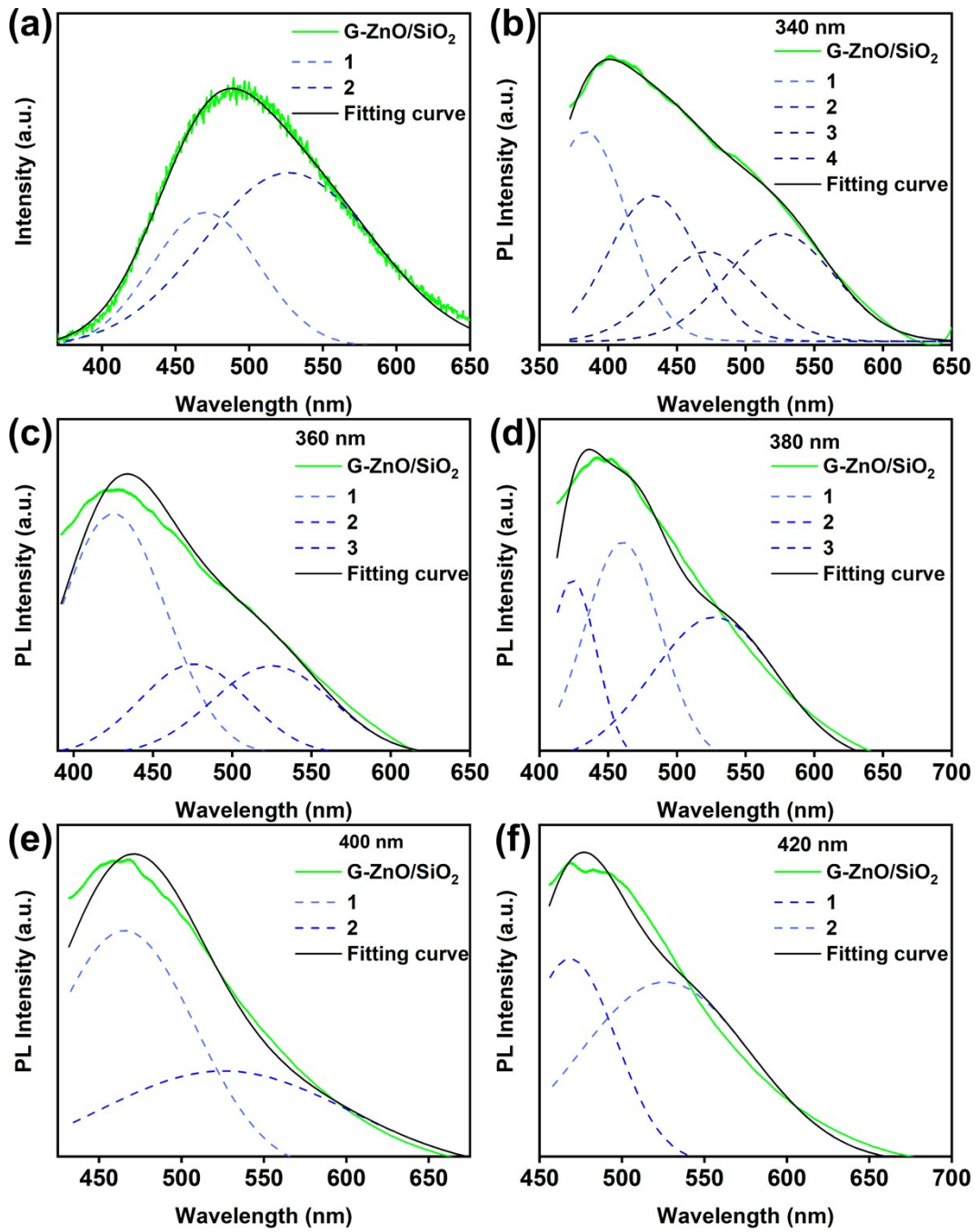
**Scheme S1.** The synthesis route of the multicolor phosphorescence ZnO/SiO<sub>2</sub>.



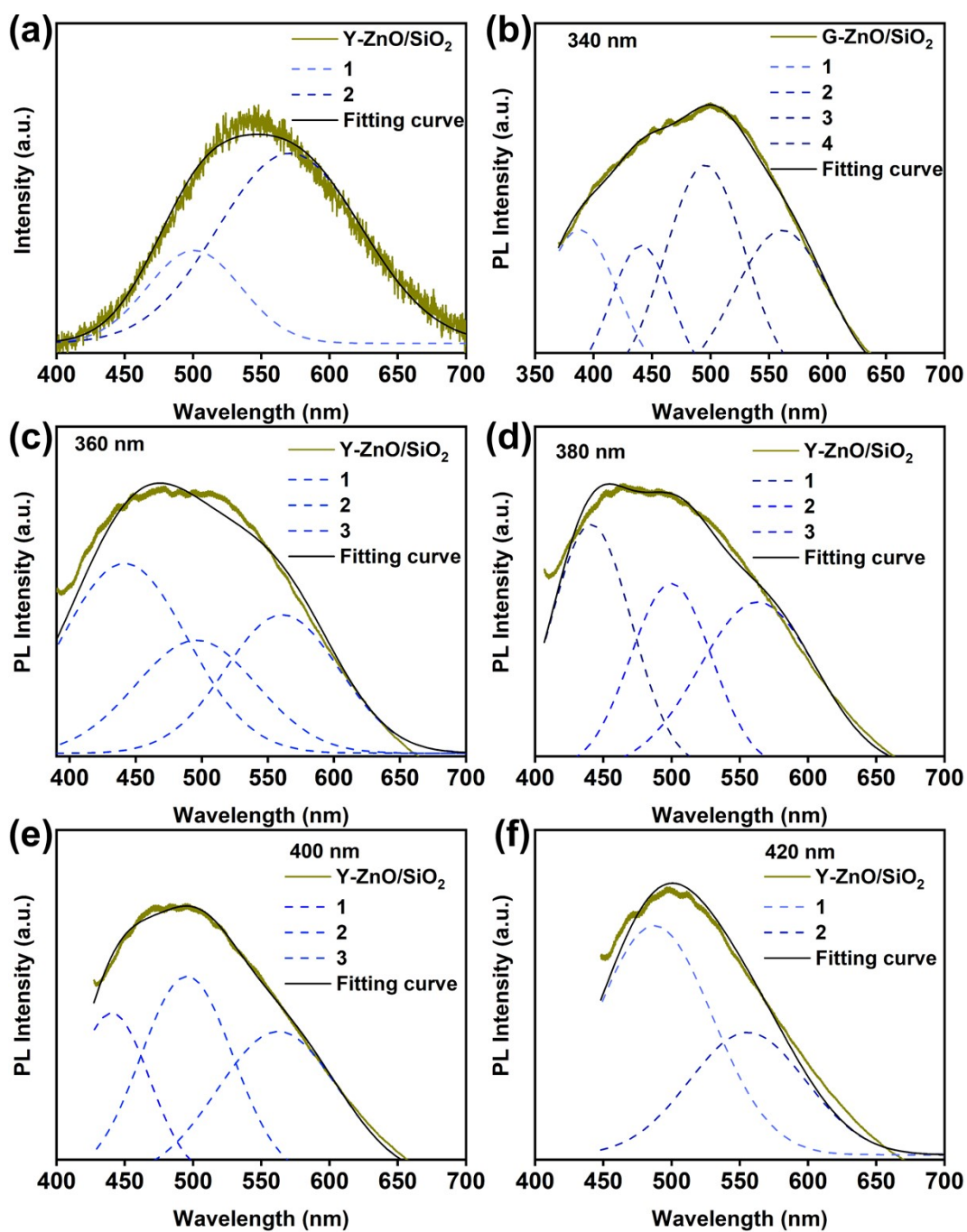
**Figure S1.** (a) PL spectra of B-ZnO/SiO<sub>2</sub> and (b) the fitted  $k$  value of B-ZnO/SiO<sub>2</sub>. (c) PL spectra of Y-ZnO/SiO<sub>2</sub> and (d) the fitted  $k$  value of Y-ZnO/SiO<sub>2</sub>.



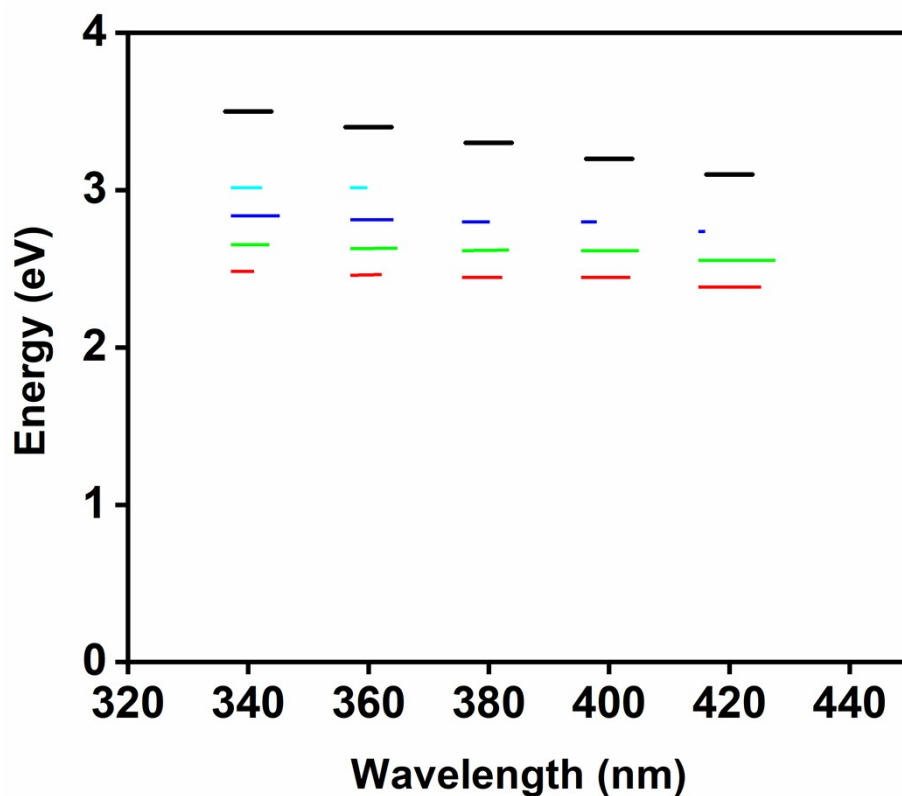
**Figure S2.** (a) Phosphorescence spectrum of B-ZnO/SiO<sub>2</sub> with fitting lines. PL spectra of B-ZnO/SiO<sub>2</sub> excited by (b) 340 nm, (c) 360 nm, (d) 380 nm, (e) 400 nm and (f) 420 nm with with fitting lines.



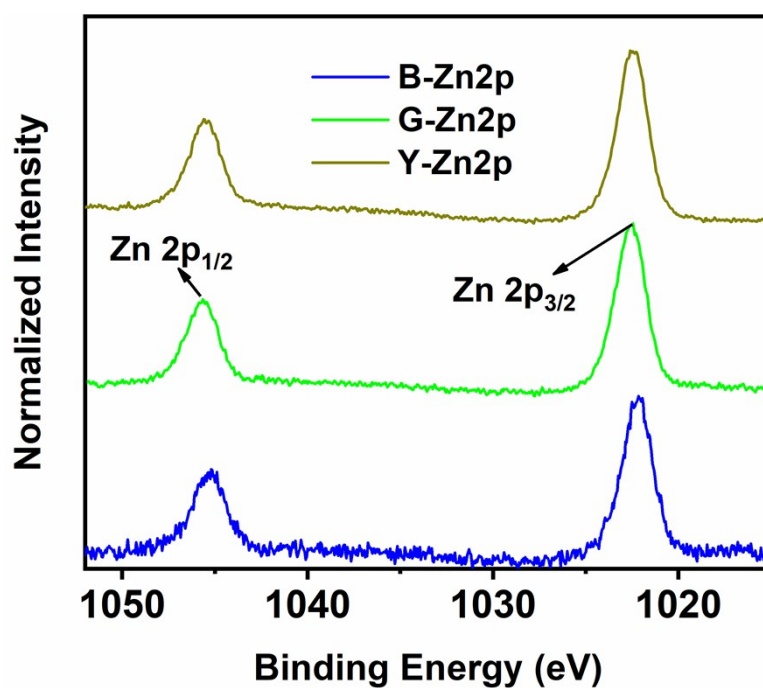
**Figure S3.** (a) Phosphorescence spectrum of G-ZnO/SiO<sub>2</sub> with fitting lines. PL spectra of G-ZnO/SiO<sub>2</sub> excited by (b) 340 nm, (c) 360 nm, (d) 380 nm, (e) 400 nm and (f) 420 nm with with fitting lines.



**Figure S4.** (a) Phosphorescence spectrum of Y-ZnO/SiO<sub>2</sub> with fitting lines. PL spectra of Y-ZnO/SiO<sub>2</sub> excited by (b) 340 nm, (c) 360 nm, (d) 380 nm, (e) 400 nm and (f) 420 nm with with fitting lines.



**Figure S5.** Excitation-dependent PL spectra were fitted to Gaussian functions (as shown in Figure S2-S4), and the resulting peak positions are shown for each excitation photon energy case. The black horizontal bars show the excitation energies, and bars colored cyan, blue, green and red show the resulting emission peak energies. The length of each of the latter is scaled to show the relative amplitude of each of the fitted Gaussians in each group.



**Figure S6.** XPS spectra of B-ZnO/SiO<sub>2</sub>, G-ZnO/SiO<sub>2</sub> and Y-ZnO/SiO<sub>2</sub>.

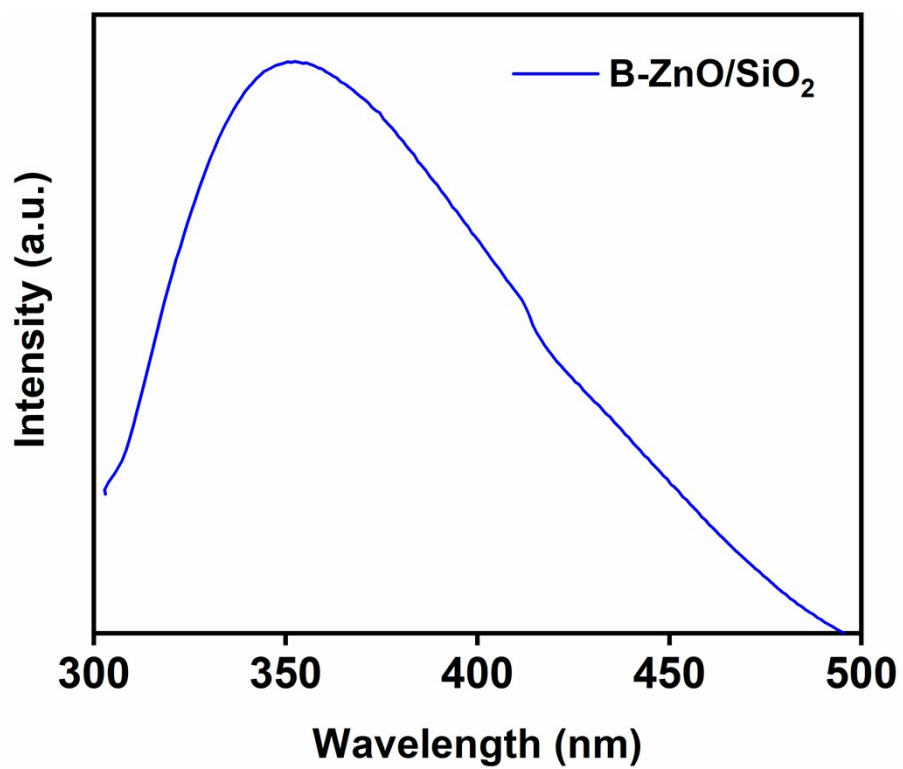


Figure S7. TL spectrum of B-ZnO/SiO<sub>2</sub>.

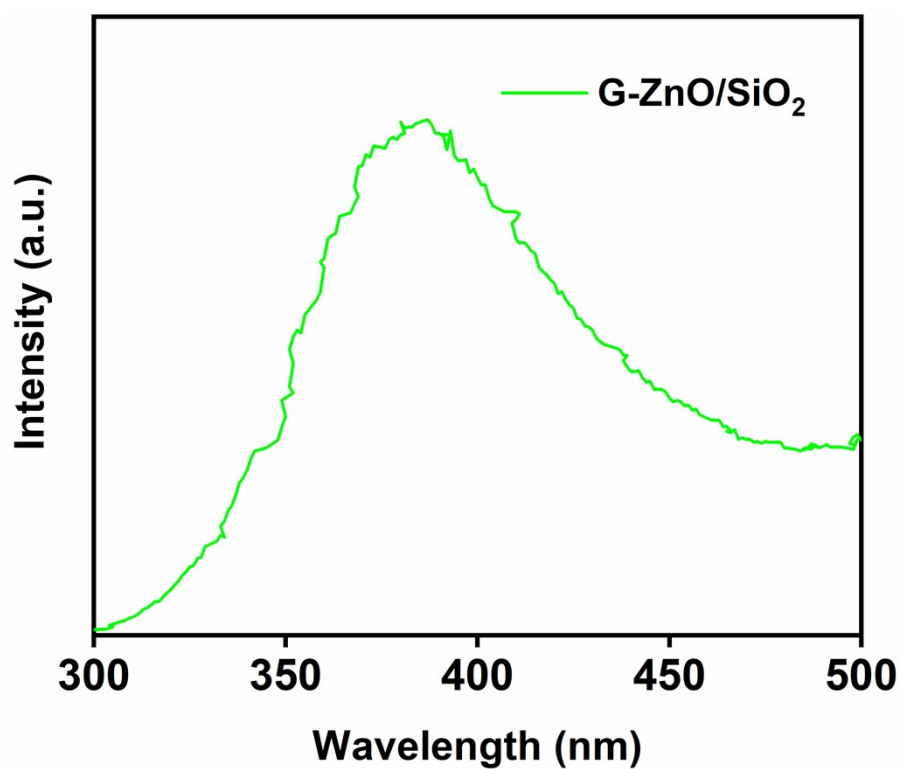


Figure S8. TL spectrum of G-ZnO/SiO<sub>2</sub>.

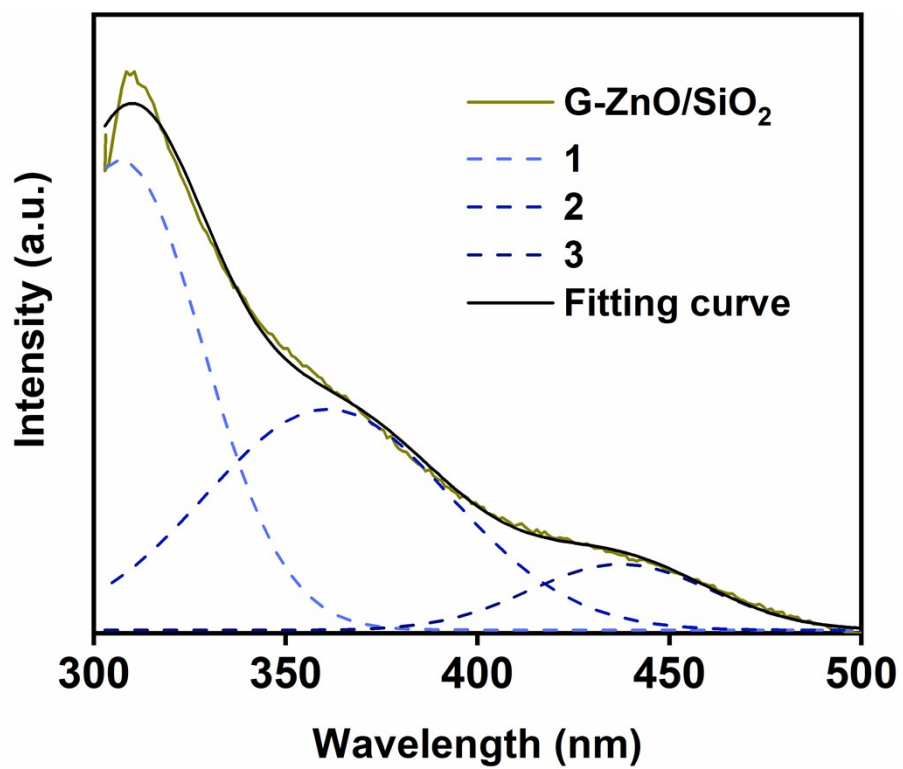
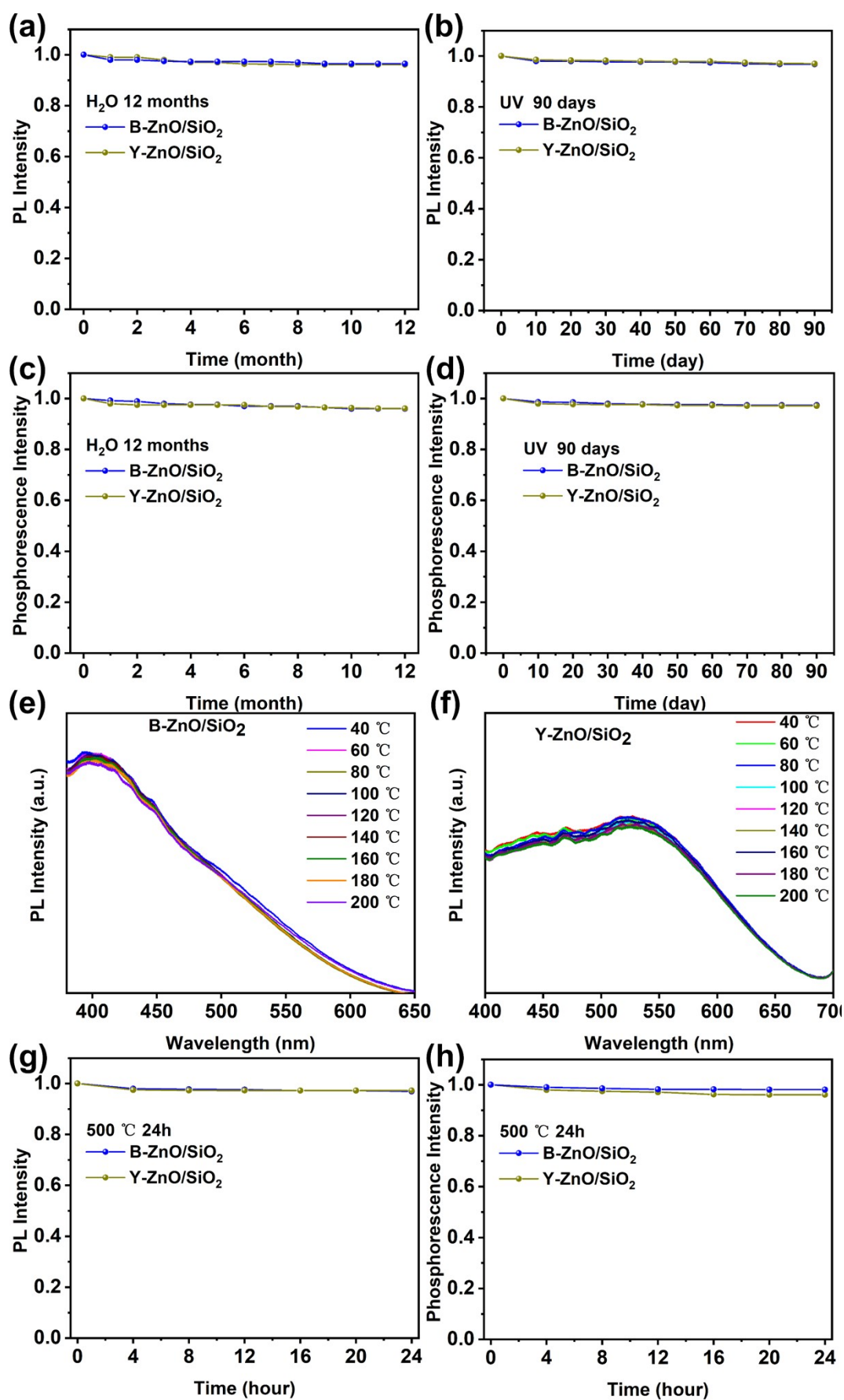


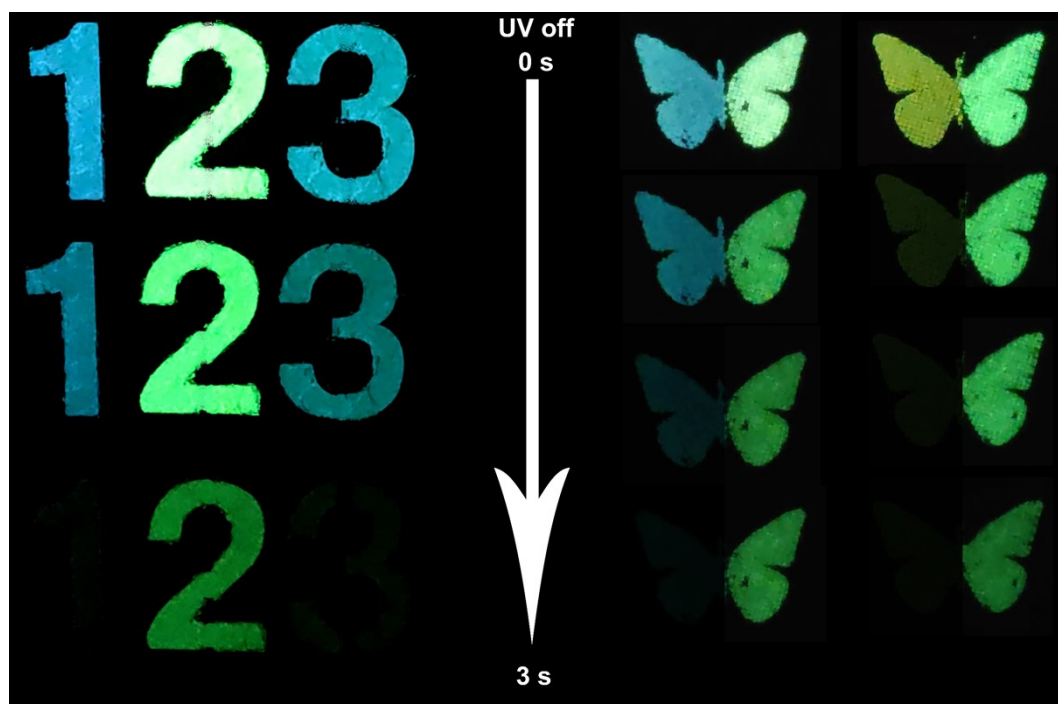
Figure S9. TL spectrum of Y-ZnO/SiO<sub>2</sub> with fitting curves.



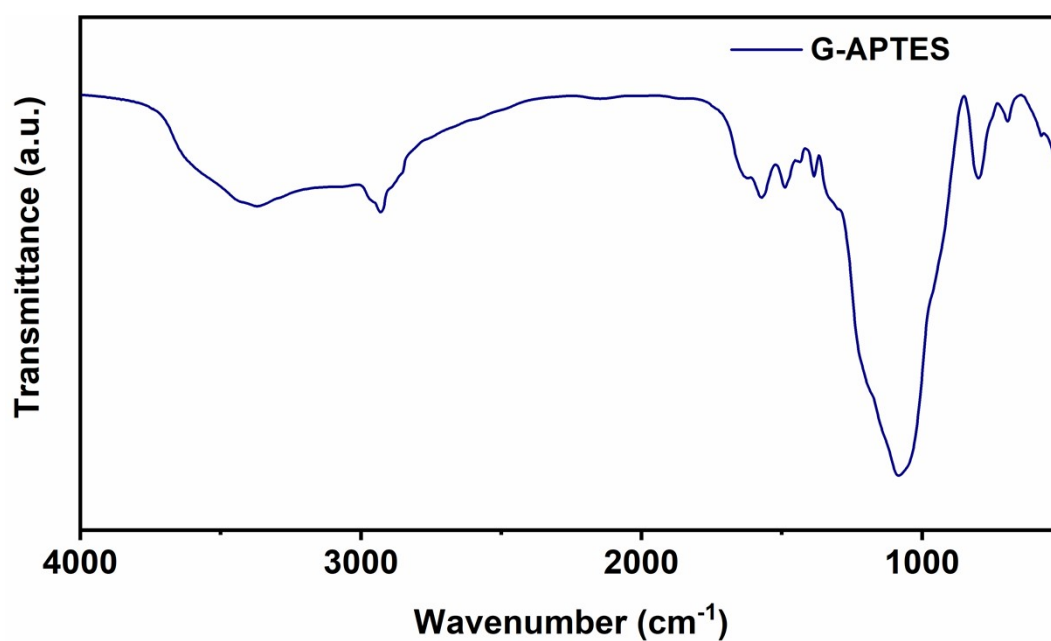


**Figure S10.** Relative PL intensity of B-ZnO/SiO<sub>2</sub> and Y-ZnO/SiO<sub>2</sub> (a) in water for different months and (b) under UV irradiation for different days. Relative phosphorescence intensity of

B-ZnO/SiO<sub>2</sub> and Y-ZnO/SiO<sub>2</sub> (c) in water for different months and (d) under UV irradiation for different days. PL spectra of (e) B-ZnO/SiO<sub>2</sub> and (f) Y-ZnO/SiO<sub>2</sub> at different temperature. (g) Relative PL intensity and (h) relative phosphorescence intensity of B-ZnO/SiO<sub>2</sub> and Y-ZnO/SiO<sub>2</sub> in 500 °C for different hours.



**Figure S11.** Photographs of the colored encrypted patterns at different delay times after 365 nm irradiation.



**Figure S12.** FTIR spectrum of G-ZnO/SiO<sub>2</sub> treated by APTES.

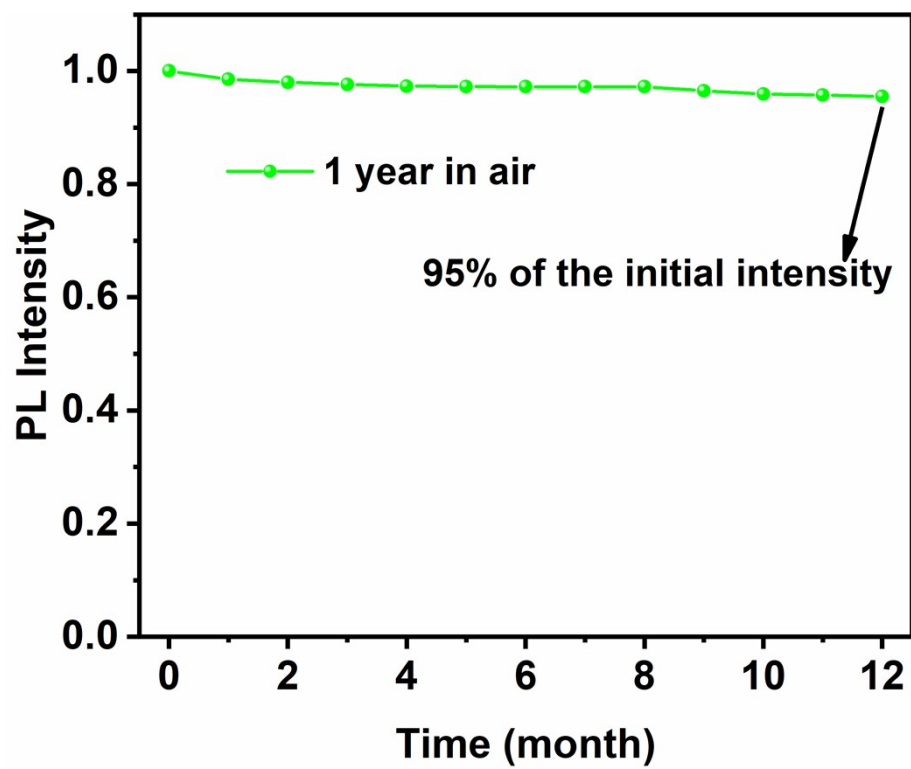


Figure S13. Relative PL intensity of G-ZnO/SiO<sub>2</sub> in air.