Supplementary Information

Sustainable Photocatalytic Removal of Cosmetic Preservatives Parabens over a Dual S-Scheme $TiO_2/ZnO/g\text{-}C_3N_4$ Catalyst under Natural Sunlight Irradiation

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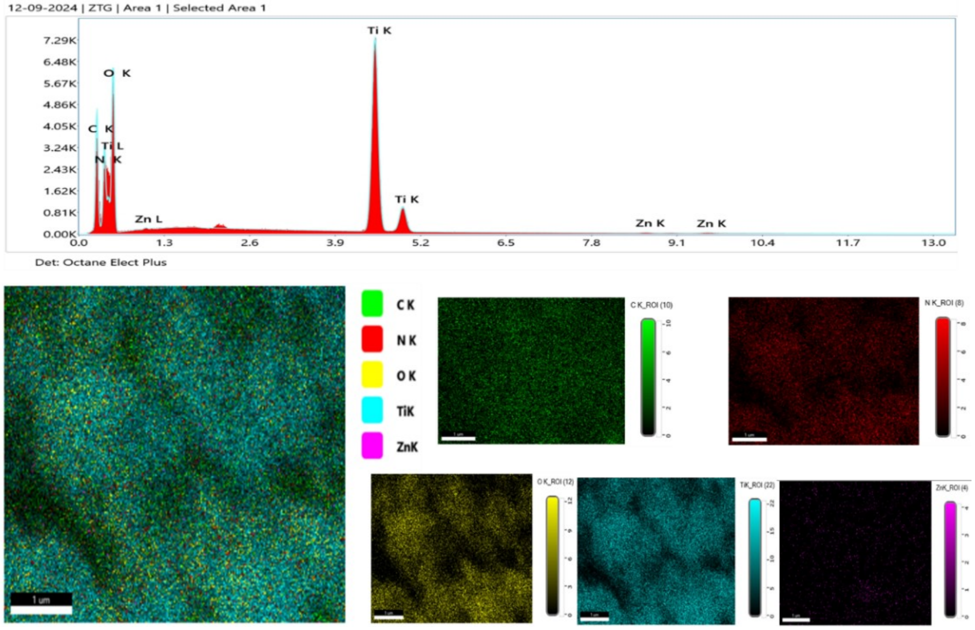

Fig. S1: EDAX pattern of TZC heterojunction

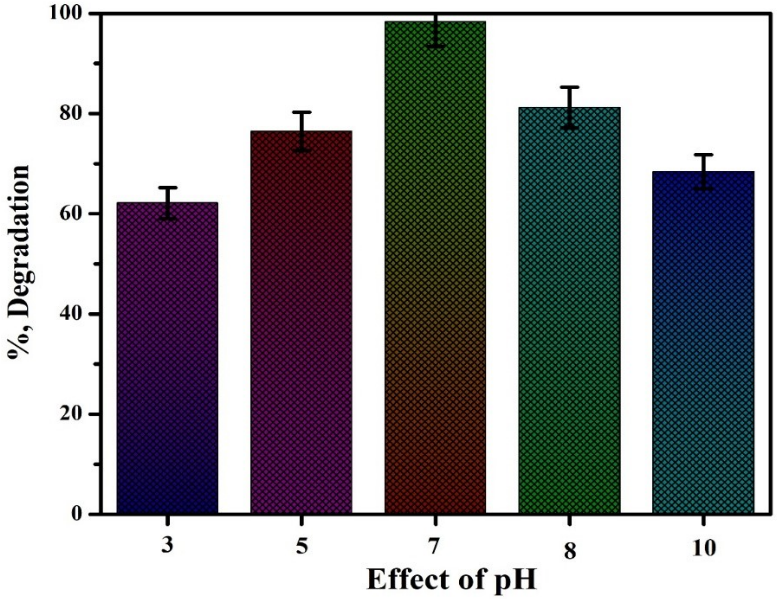

Fig. S2: Effect of pH variation on the degradation efficiency of EtP

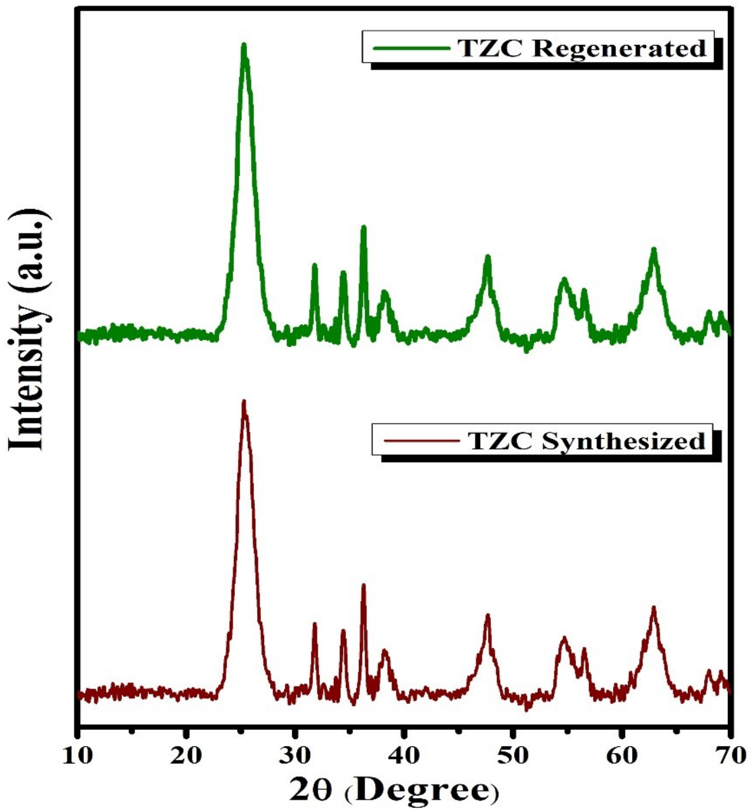

Fig. S3: XRD analysis of TZC synthesized and regenerated

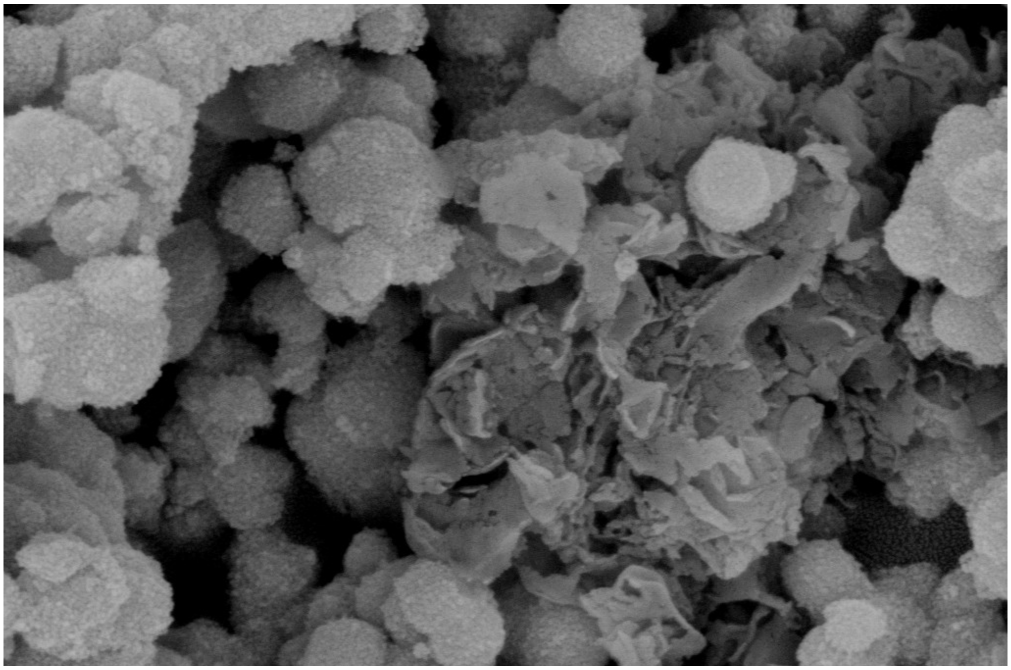

Fig. S4: FE SEM analysis of regenerated TZC

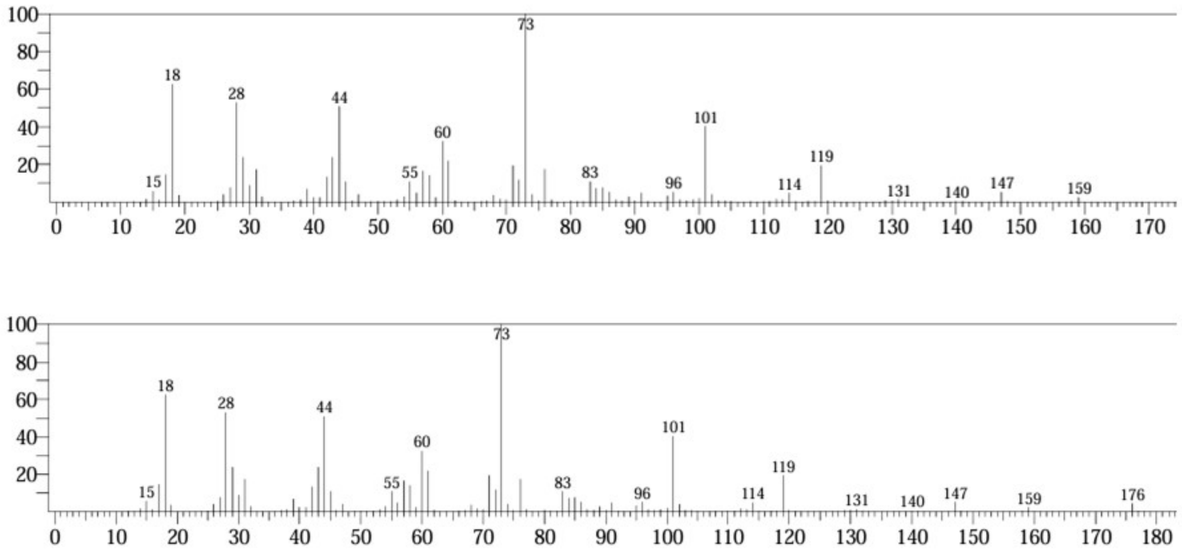

Fig. S5: LCMS spectra of EtP degradation

Mott-Schottky analysis:

The Mott-Schottky analysis of ZnO, TiO_2, and g-C_3N_4 was conducted to determine their flat-band potentials and semiconductor characteristics **(Fig. S6).** The positive slopes of the $1/C^2$ vs. potential plots for all materials confirm their n-type nature. The flat-band potential of ZnO was found to be approximately -0.75 V vs. SHE, while that of TiO_2 was around −0.69 V vs. SHE. The flat-band potential of g-C_3N_4 was -1.28 V. When converted to a common reference scale, these values indicate that the conduction band of g-C_3N_4 is more negative than ZnO and TiO_2, whereas the valence band of ZnO and TiO_2 is more positive, fulfilling the energetic requirements for S-scheme operation. Upon contact, an internal electric field (IEF) forms at the interface, directing electrons from g-C_3N_4 to ZnO and TiO_2 while the holes in the opposite direction. Under light irradiation, photogenerated electrons in the conduction band of ZnO and TiO_2 recombine with holes in the valence band of g-C_3N_4. This retains the highly reductive electrons in g-C_3N_4 along with highly oxidative holes in ZnO and TiO_2, enhancing the redox ability. Thus, the Mott-Schottky results provide strong evidence supporting the formation of a dual S-scheme heterojunction, which facilitates efficient charge separation and promotes photocatalytic degradation of EtP.

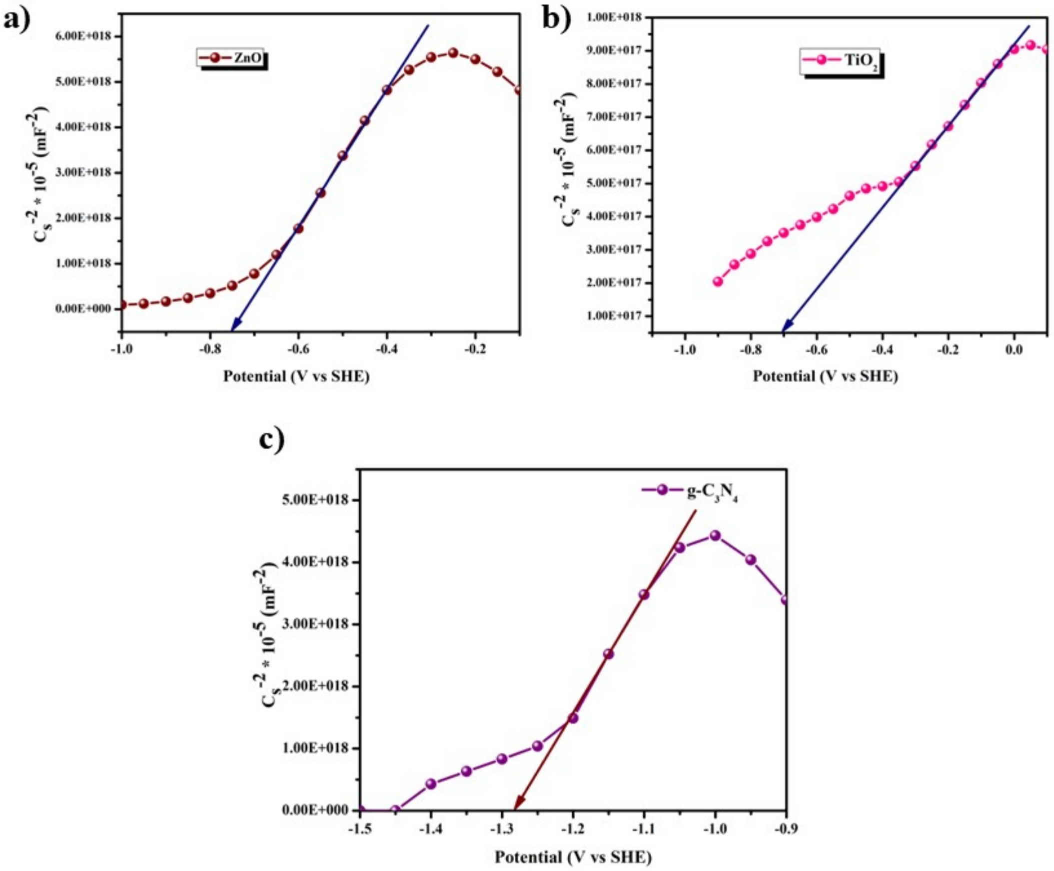

Fig. S6: Mott-Schottky analysis of ZnO, TiO_2, g-C_3N_4 individually

Entry	Catalyst	Catalyst Dosage (gL^{-1})	EtP (mgL^{-1})	Source; duration; pH	Degradation, %	Ref.
1	CuOx/BiVO4	0.5	0.5	Sunlight/1h	98	1
2	Ag_3PO_4	0.5	1.5	Sunlight/1h	90	2
3	$Bi_2Ti_2O_7/TiO_2$	1	10	500 W UV/30 min	91	3
4	rGO/TiO_2	0.7 L^{-1}	15	UV /40 min	98	4
5	MI-Ag-TiO_2	0.3	10	500 W UV/ 2 h	93	5
6	$Ag/BiVO_4$	0.5	10	40 W LED/ 4 h	94	6
7	$TiO_2/ZnO/g$-C_3N_4	1 gL^{-1}	10	Sunlight/1.5 h/7	99	Present work

Table TS1: Comparative table for the photocatalytic degradation of EtP

References

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