Supporting Information

Chemical-Vapor-Deposition-Synthesized Two-Dimensional Non-Stoichiometric Copper Selenide (β-$Cu_{2-x}Se$) for Ultra-Fast Tetracycline Hydrochloride Degradation under Solar Light

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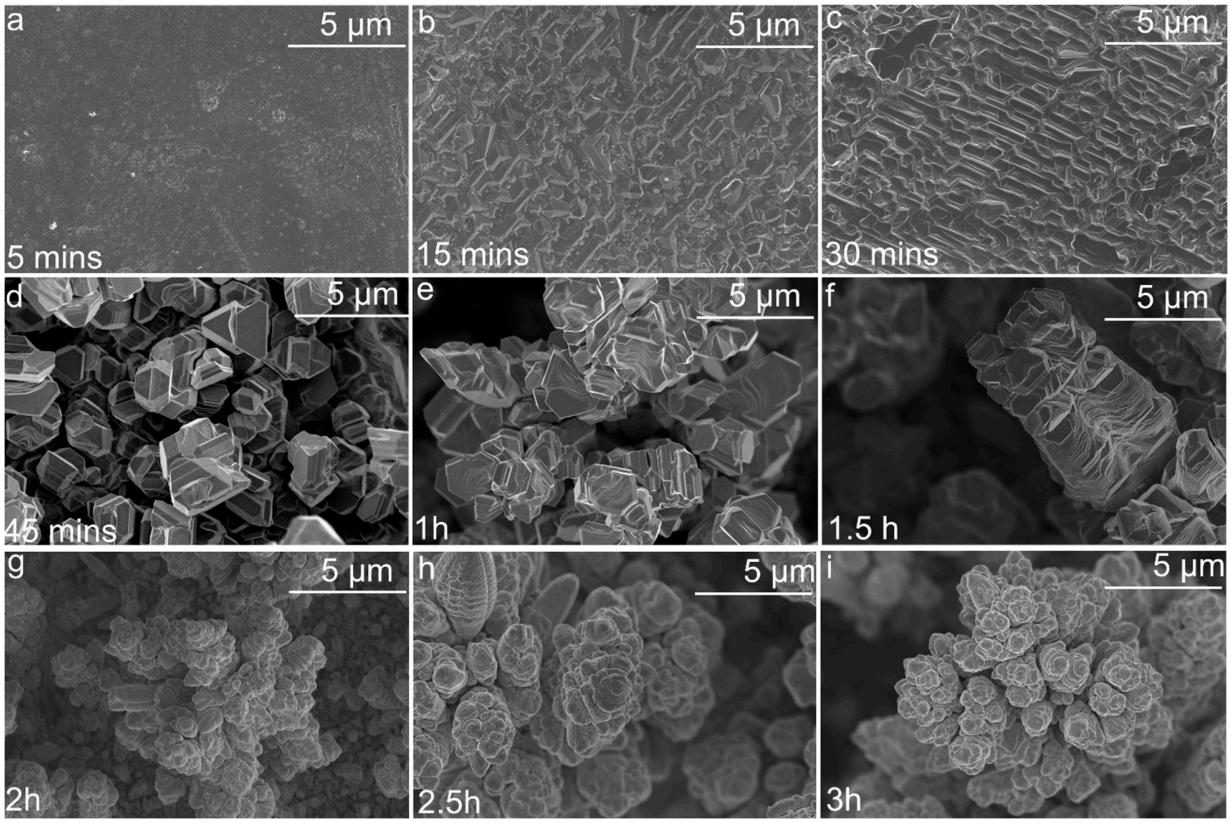

Figure S1. High-resolution scanning electron microscopy (HRSEM) shows microstructural evolution and copper selenide (β-$Cu_{2-x}Se$) formation at different reaction times (5mins to 3h) between etched Cu foil and elemental Se.

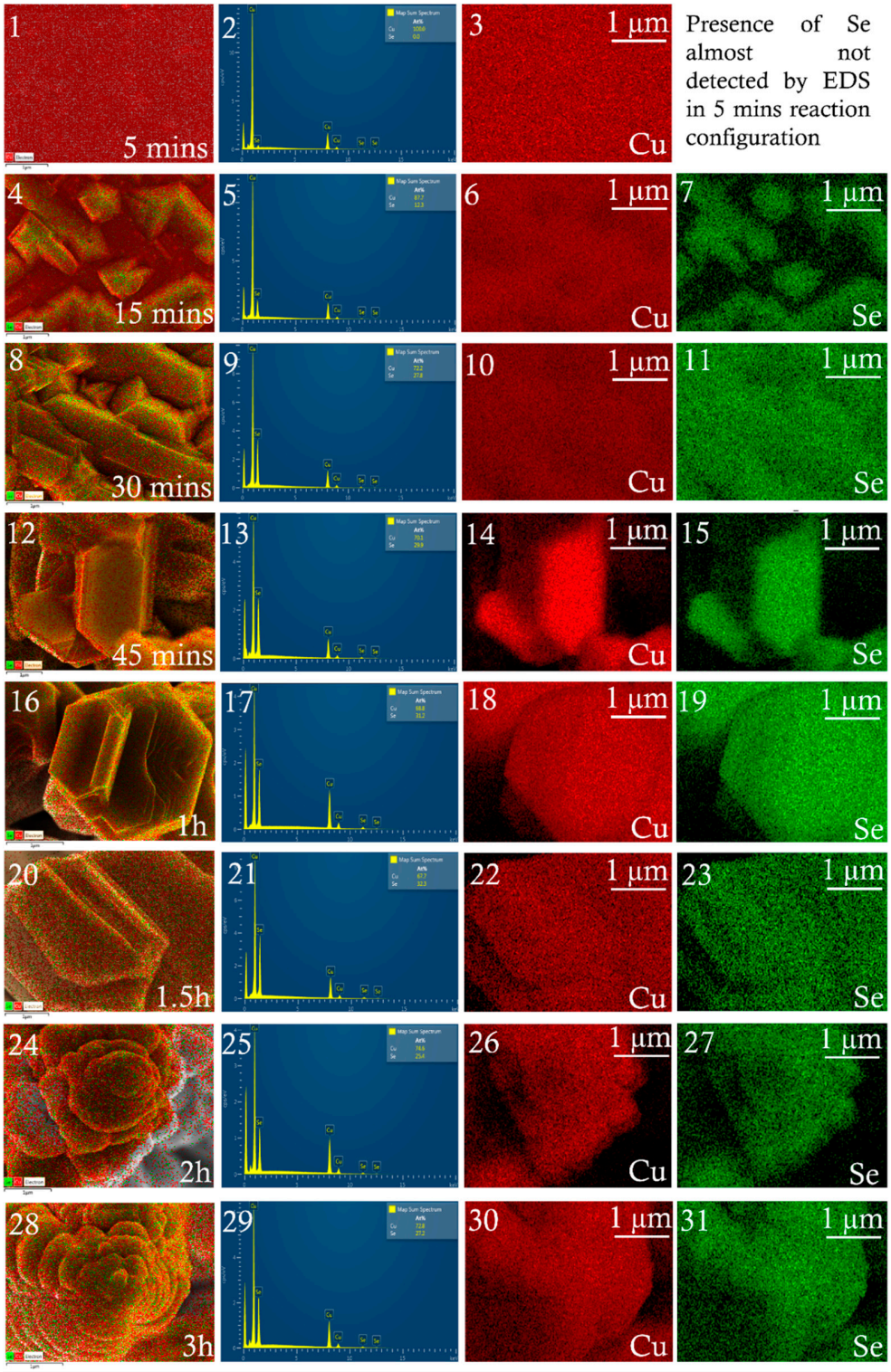

Figure S2. Ex-situ High-resolution scanning electron microscopy (HRSEM) images, Electron Dispersive Spectroscopy (EDS), and elemental mapping of Cu and Se at different reaction times indicate the formation and evolution of β-$Cu_{2-x}Se$.

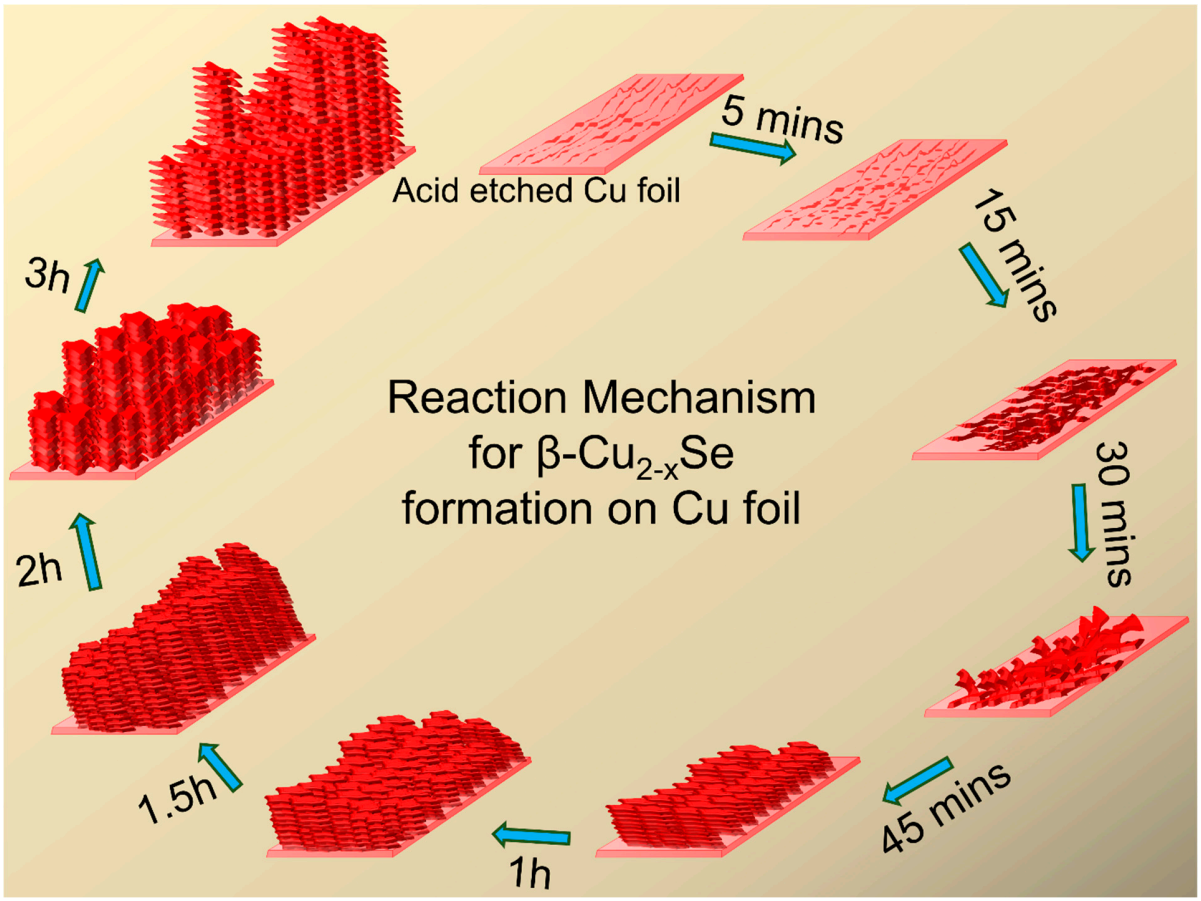

Figure S3. Proposed reaction mechanism based on the microstructural evolution and CVD-synthesis of β-$Cu_{2-x}Se$ on Cu foil.

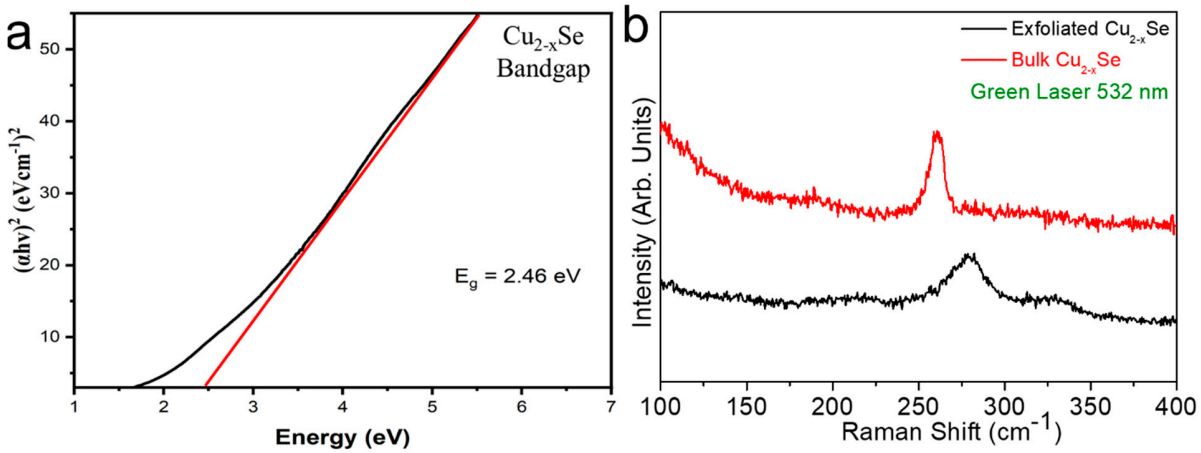

Figure S4. (a) Band gap and (b) Raman measurements of β-$Cu_{2-x}Se$.

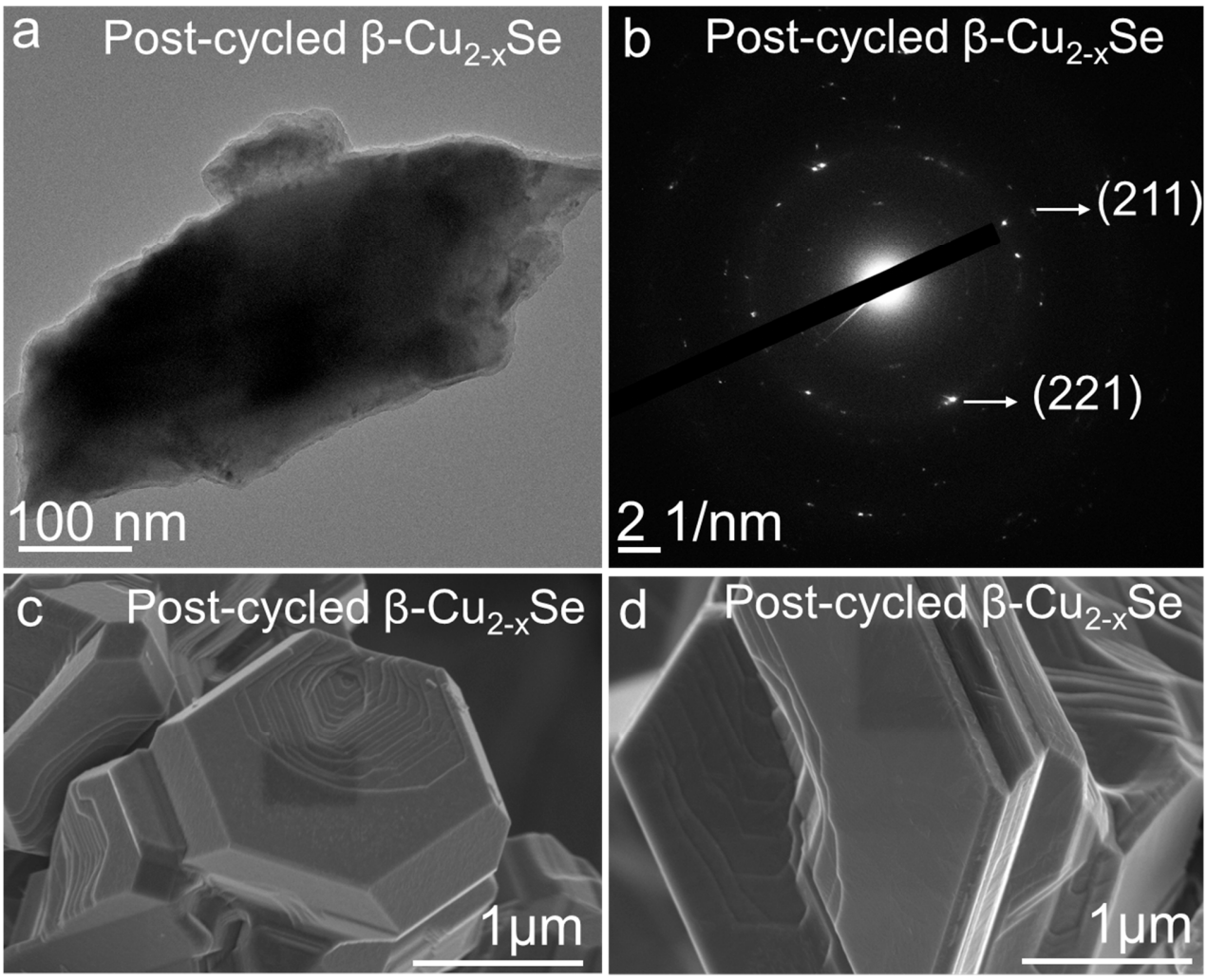

Figure S5. Post-mortem studies showing (a) High-resolution transmission electron microscopy (HRTEM) image of β-$Cu_{2-x}Se$ after photocatalytic degradation (4 cycles); (b) Selected Area Diffraction (SAED) of post-cycled β-$Cu_{2-x}Se$; (c) and (d) High-resolution scanning electron microscopy (HRSEM) images of bulk β-$Cu_{2-x}Se$ indicating that the material is very stable and does not undergo extreme microstructural changes after photocatalytic cycling (4 cycles).

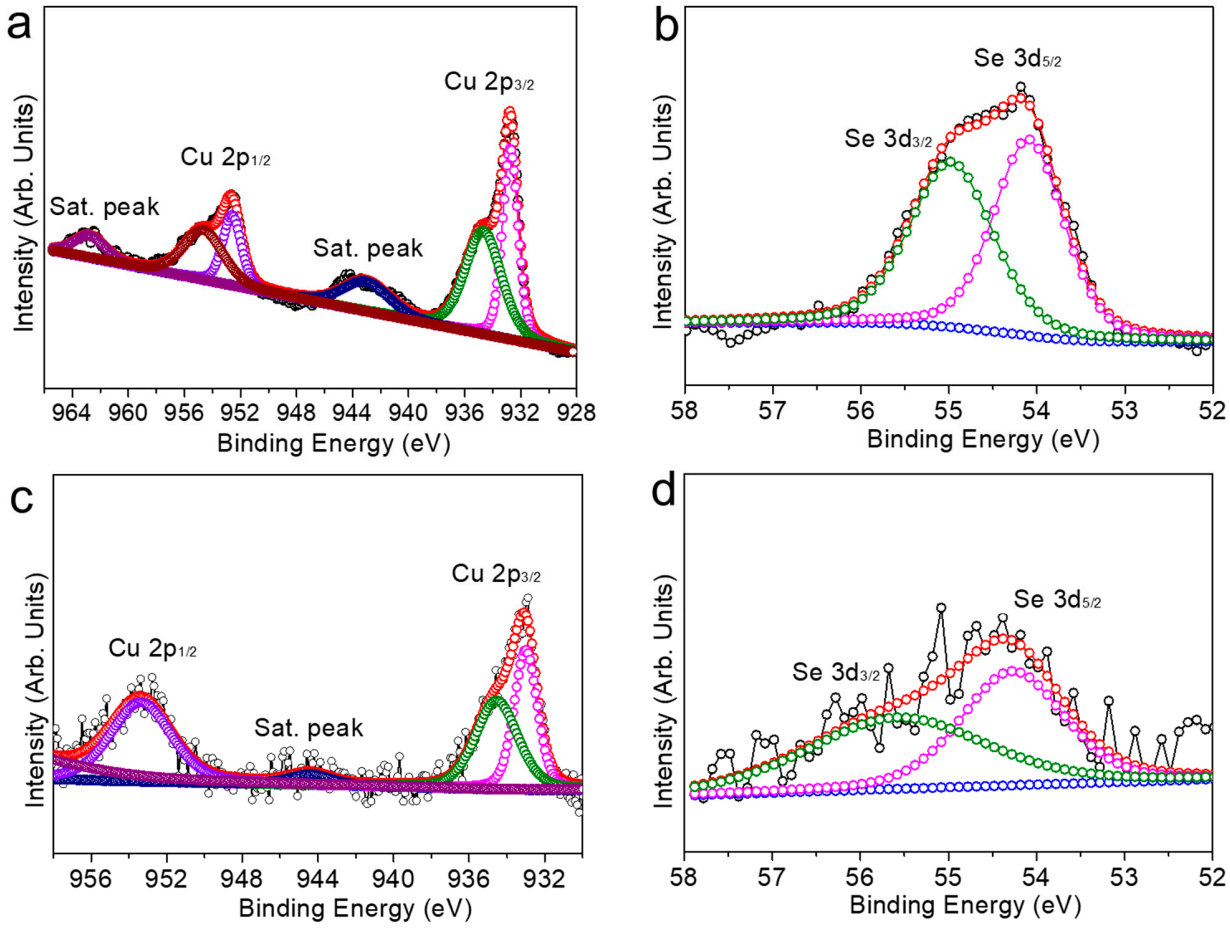

Figure S6. (a) and (b) are the X-Ray Photoelectron Spectroscopy (XPS) measurements of uncycled β-$Cu_{2-x}Se$, while (c) and (d) are the XPS) measurements of cycled β-$Cu_{2-x}Se$ under simulated solar light.

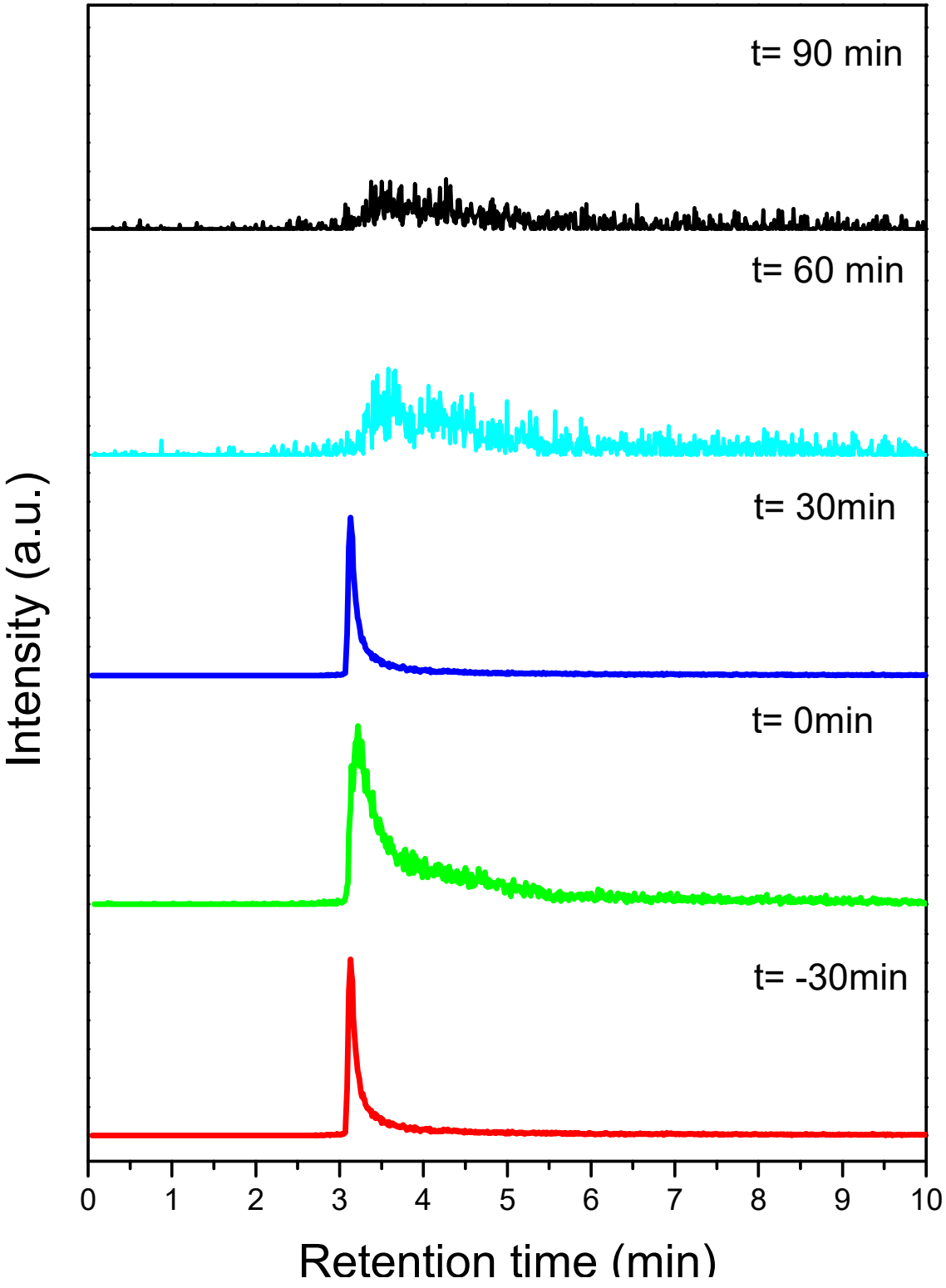

Figure S7. LC-MS of TCH degradation over β-$Cu_{2-x}Se$ under solar light irradiation.

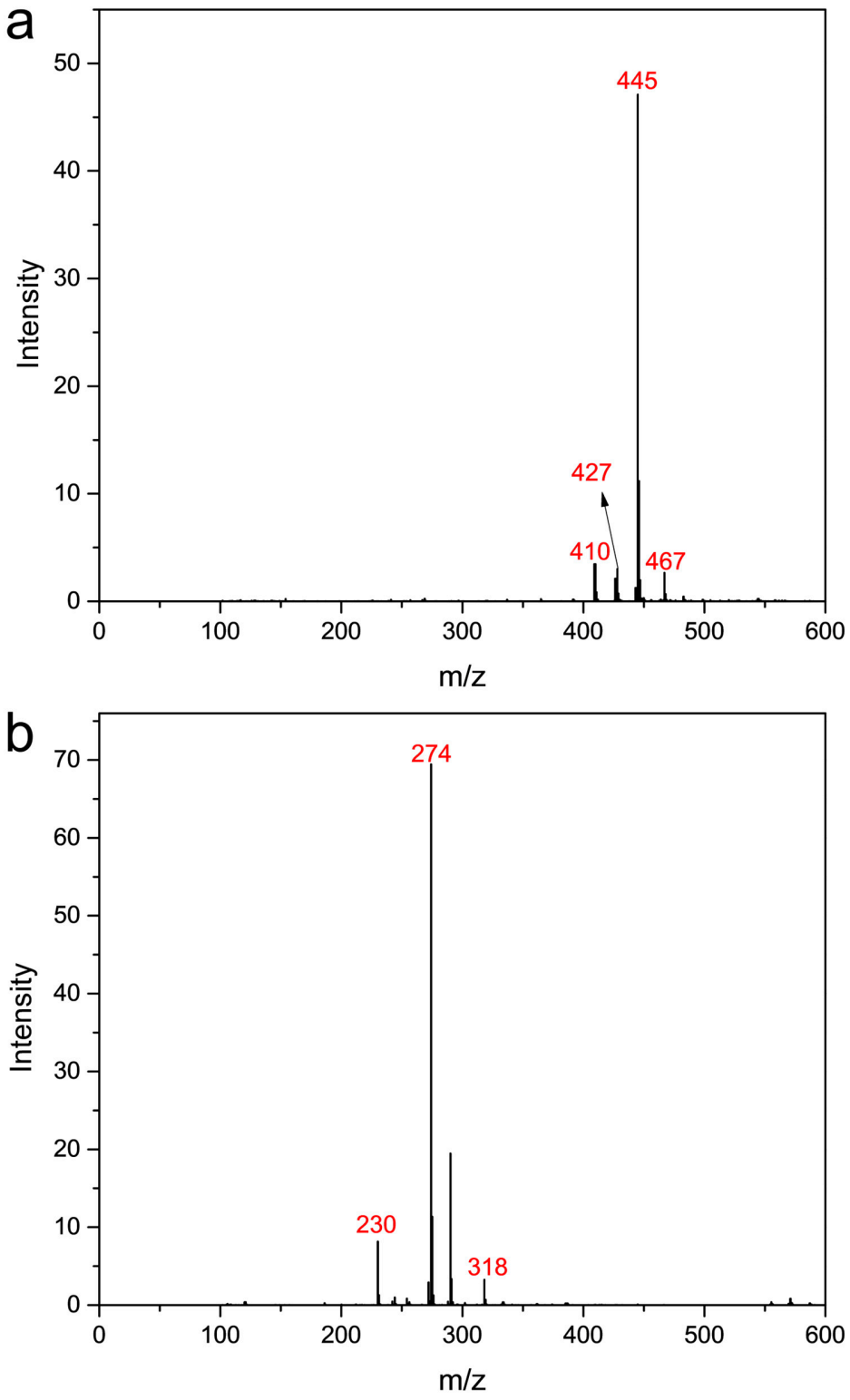

Figure S8. The mass spectra of TC-HCl transformation products: m/z = 467, 445, 427,410, 318, 274, 230.

Table S1. Comparison of TC-HCl photodegradation using different photocatalysts

Catalyst	Concentration of TC-HCl	Catalyst dosage	TC-HCl /Catalyst dosage	Degradation time	Efficiency	Reaction rate	Ref.
β-$Cu_{2-x}Se$	**20 mg/L**	**0.4 g/L**	**50 mg/g**	**90 min**	**98.35 %**	**0.0314 min^{-1}**	**Present Work**
TiS_2	20 mg/L	1 g/L	20 mg/g	300 min	95.43 %	0.0174 min^{-1}	[1]
Sn_3O_4/g-C_3N_4	10 mg/L	0.5 g/L	20 mg/g	120 min	72.2 %	0.0108 min^{-1}	[2]
CdS/Ti_{32}-oxo-cluster	50 mg/L	0.2 g/L	250 mg/g	60 min	96.3 %	0.06135 min^{-1}	[3]
$Bi_{24}O_{31}Br_{10}$	20 mg /L	0.3 g/L	67 mg/g	90 min	95 %	0.031 min^{-1}	[4]
WO_3/g-C_3N_4/Bi_2O_3	10 mg/L	1 g/L	10 mg/g	60 min	80.2 %	0.0236 min^{-1}	[5]
Ag/$AgIn_5S_8$	10 mg/L	0.3 g/L	33 mg/g	120 min	95.3 %	0.023 min^{-1}	[6]
BiOCl	10 mg/L	0.5 g/L	20 mg/g	90 min	71.8 %	0.0139 min^{-1}	[7]
WO_3/g-C_3N_4	20 mg/L	1 g/L	20 mg/g	60 min	90.54 %	0.0378 min^{-1}	[8]
CNFs/g-C_3N_4/BiOBr	20 mg/L	3 g/L	6.7 mg/g	120 min	86.1 %	0.015 min^{-1}	[9]
CDs/MoO3/g-C3N4	20 mg/L	0.6 g/L	33.3 mg/g	90 min	88.4 %	0.0231 min^{-1}	[10]
$ZnIn_2S_4$/MoO_3	30 mg/L	0.15 g/L	200 mg/g	90 min	94.5 %	0.0292 min^{-1}	[11]

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