Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supporting Information

Highly selective phenol production from benzene on platinum-loaded tungsten oxide photocatalyst with water and molecular oxygen: Selective oxidation of water by holes for generating hydroxyl radical as predominant source of hydroxyl group

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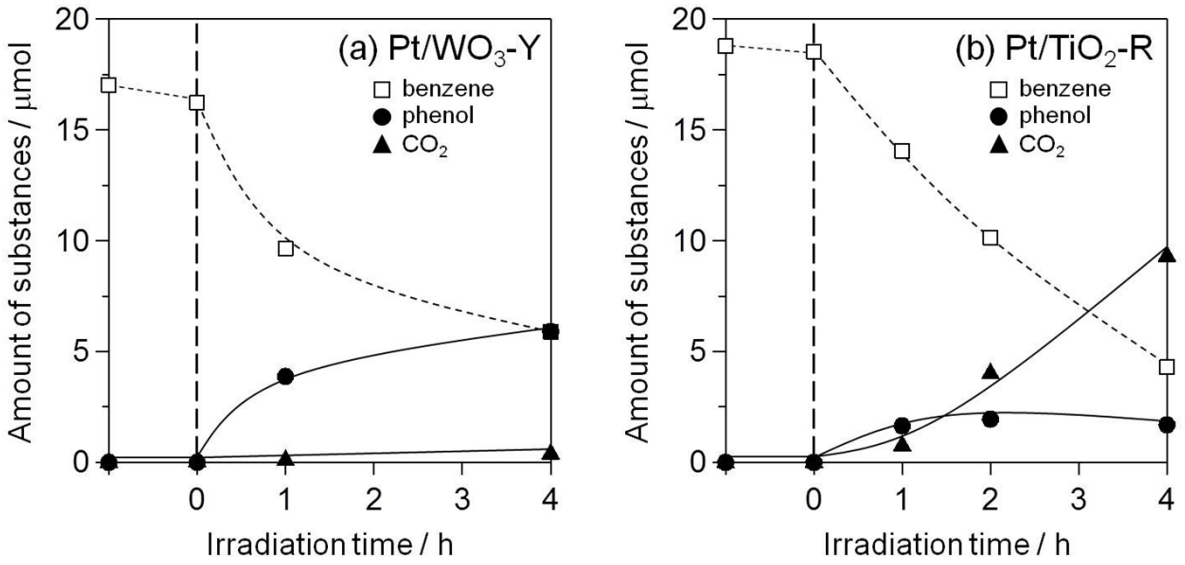

Figure S1. Time course of hydroxylation and oxidation of benzene over (a) Pt/WO_3-Y and (b) Pt/TiO_2-R photocatalysts in aerated aqueous solutions of benzene (18.8 μmol) under ultraviolet and visible light irradiation ($300 < \lambda < 500$ nm).

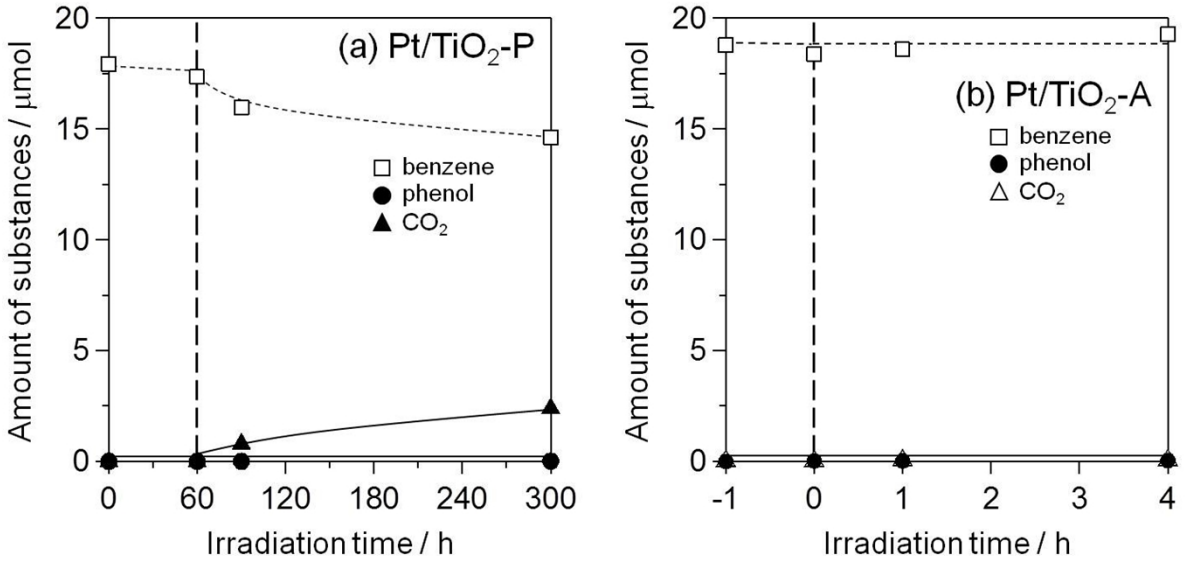

Figure S2. Time course of photocatalytic oxidation of benzene over (a) Pt/TiO_2-P and (b) Pt/TiO_2-A photocatalysts in aerated aqueous solutions of benzene (18.8 μmol) under visible light irradiation ($400 < \lambda < 500$ nm).

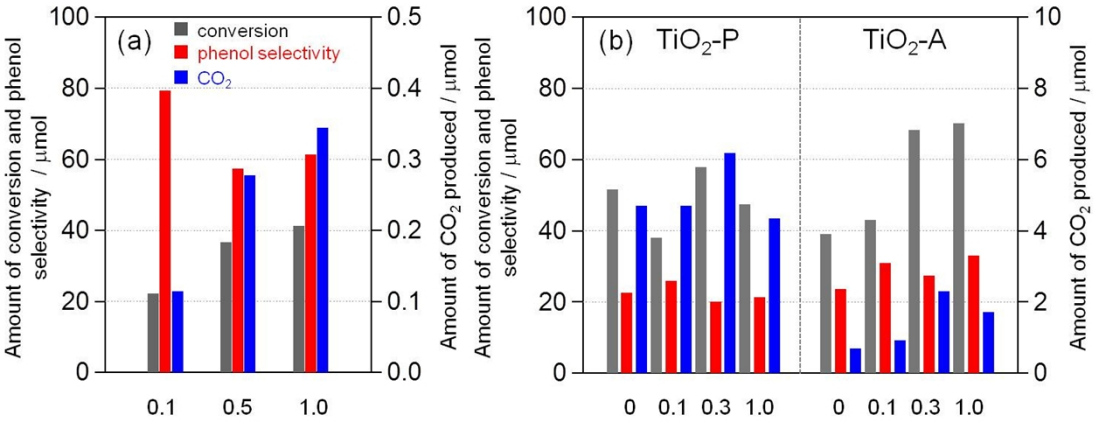

Figure S3. Influence of Pt amount on the amount of conversion, phenol selectivity, and amount of CO_2 on (a) Pt/WO_3-K and (b) TiO_2 photocatalyst during hydroxylation of benzene (irradiation time 1 h).

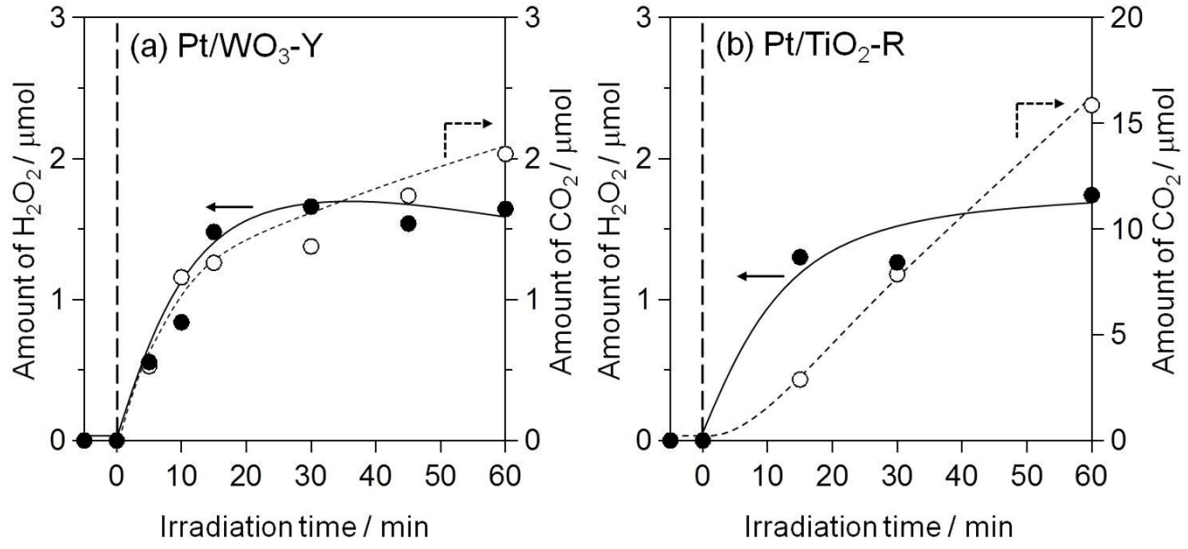

Figure S4. Time course curves of H_2O_2 and CO_2 generation over (a) Pt/WO_3-Y and (b) Pt/TiO_2-R photocatalysts suspended in AcOH solution under ultraviolet and visible light irradiation ($300 < \lambda < 500$ nm).

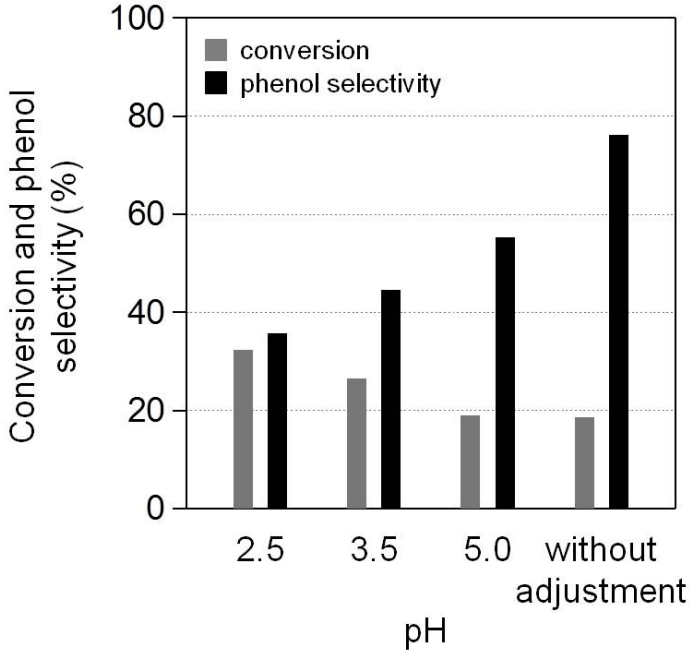

Figure S5. Dependence of photocatalytic hydroxylation of benzene on pH for use of Pt/WO_3-K photocatalyst.

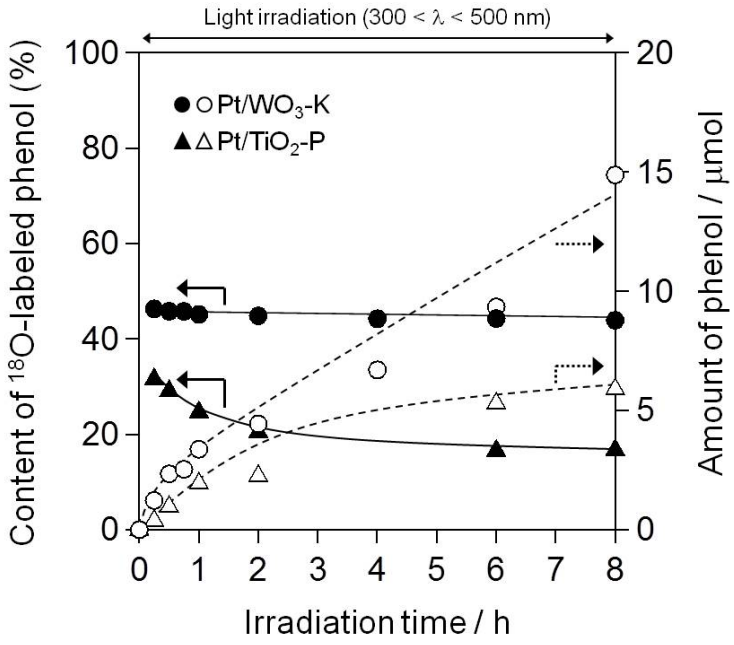

Figure S6. Time course of photocatalyzed phenol productionfrom benzene on Pt/WO_3-K and Pt/TiO_2-P samples. Reactions were conducted in $H_2{}^{16}O$-$H_2{}^{18}O$ mixed solvent containing benzene and normal molecular $^{16}O_2$.

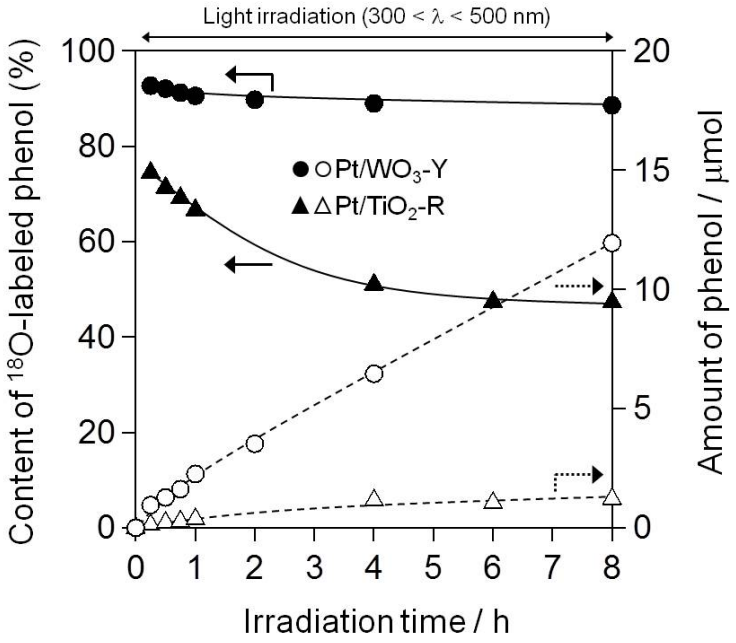

Figure S7. Time course of photocatalyzed phenol production from benzsene on Pt/WO_3-Y and Pt/TiO_2-R samples. Reactions were conducted in ^{18}O-enriched water (98% $H_2{}^{18}O$) containing benzene and normal molecular $^{16}O_2$.

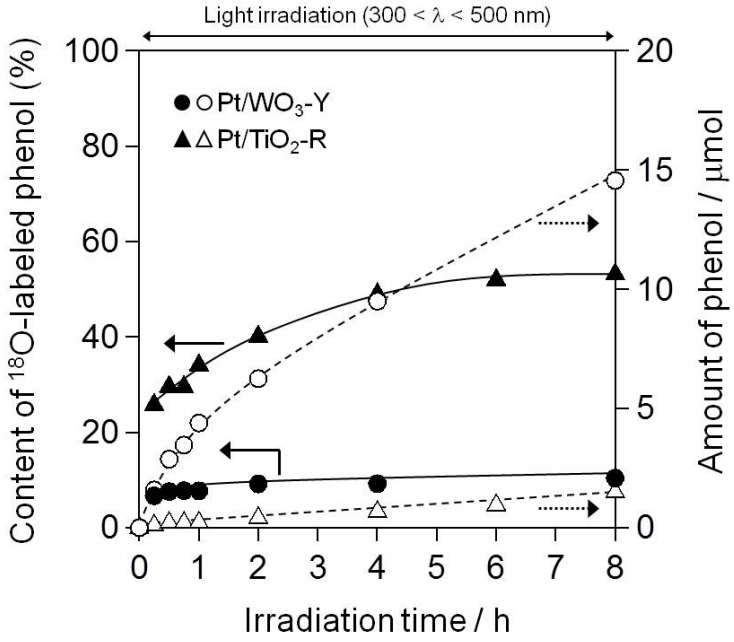

Figure S8. Time course of photocatalyzed phenol production from benzene on Pt/WO_3-Y and Pt/TiO_2-R samples. Reactions were conducted in normal water ($H_2{}^{16}O$) containing benzene and molecular $^{18}O_2$.

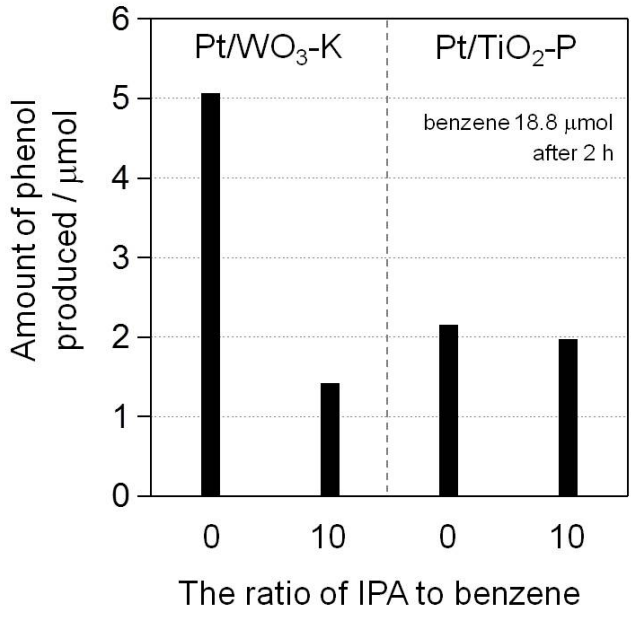

Figure S9. Amount of phenol produced from hydroxylation of benzene in the presence of IPA over Pt/WO_3-K and Pt/TiO_2-P photocatalysts.

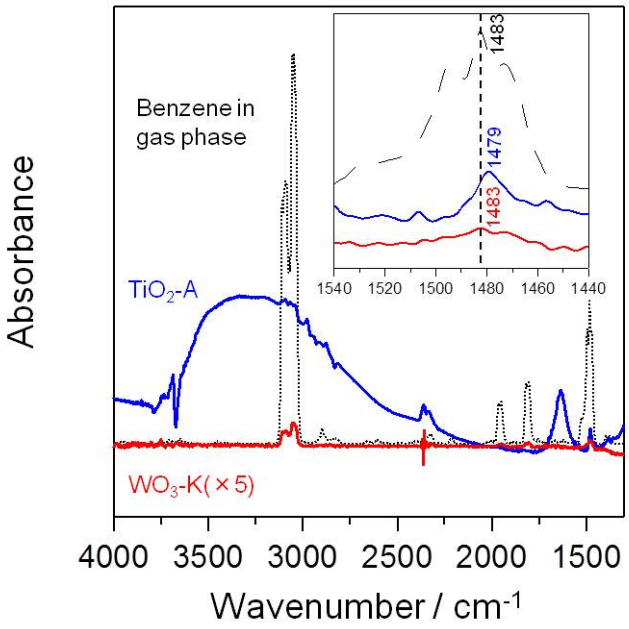

Figure S10. FT-IR subtraction spectra of benzene on photocatalysts.

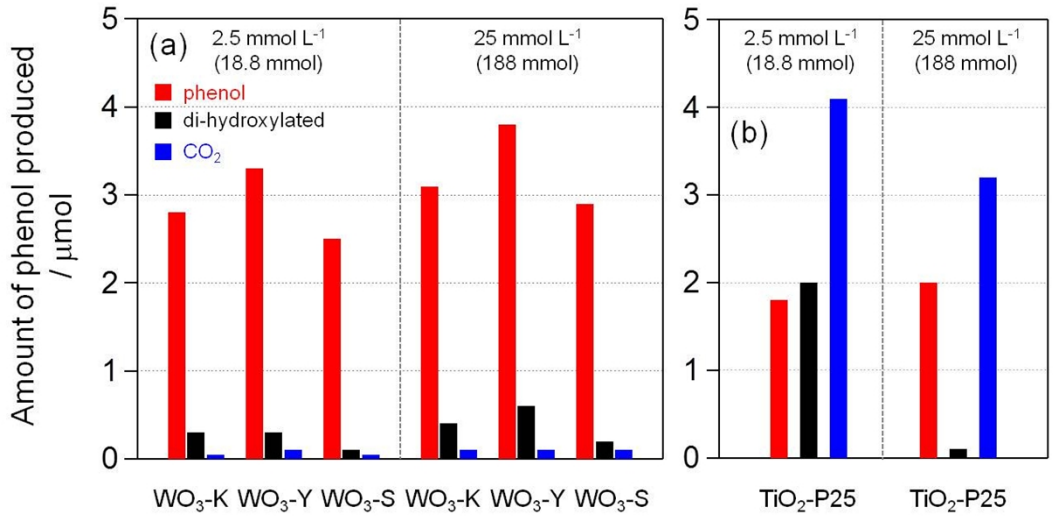

Figure S11. Influence of initial concentration of benzene on the amount of phenol, di-hydroxylated benzene and CO_2 on (a) Pt/WO_3 and (b) TiO_2 photocatalysts during hydroxylation of benzene (Pt: 0.1 wt.%).

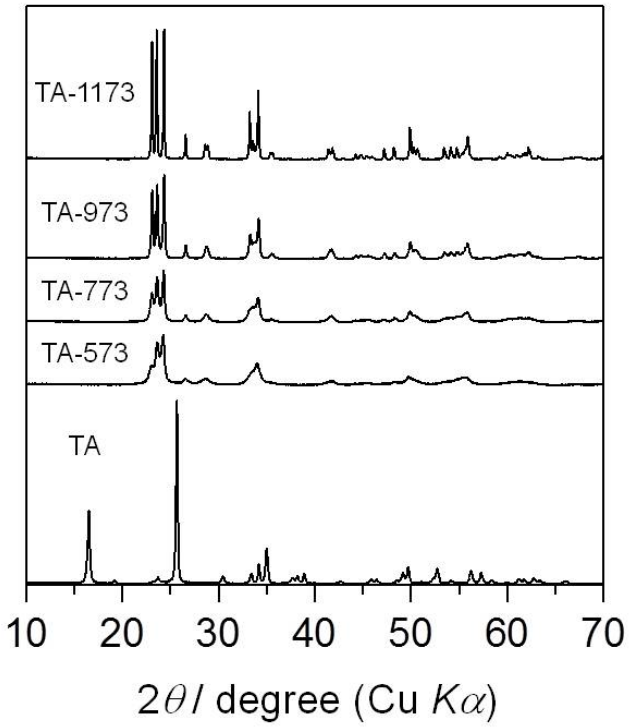

Figure S12. XRD pattern of WO_3 samples obtained from tungstic acid (H_2WO_4, TA) as the W precursor.

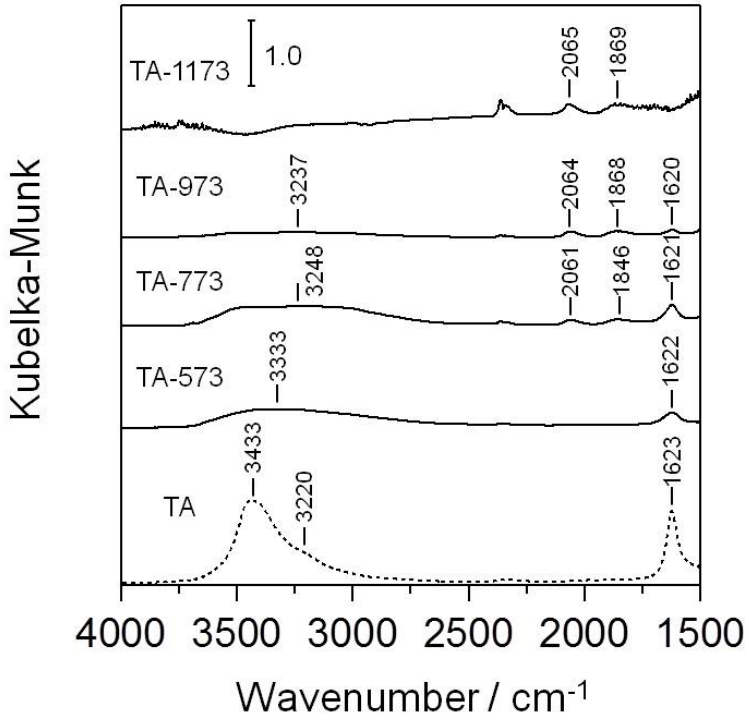

Figure S13. IR spectra of WO_3 samples obtained from tungstic acid (H_2WO_4, TA) as the W precursor.

Table S1. Direct hydroxylation of benzene to phenol on WO_3-TA (prepared by calcination of tungstic acid powder) in normal water ($H_2{}^{16}O$) containing benzene and molecular $^{18}O_2$.

Entry	Calcination temperature / K	Content of labeled phenol (%) (Amount of phenol produced / μmol)	
		1 h	8 h
1	573	95.1 (0.6)	95.2 (2.5)
2	773	94.4 (1.2)	92.0 (3.8)
3	973	96.3 (1.3)	93.3 (4.9)
4	1173	94.9 (0.9)	94.0 (2.2)

Initial concentration of benzene : 500 μmol, Amount of solvent : 1.0 mL

Light source : 300 W Xe lamp ($300 < \lambda < 500$ nm)