Supplementary Information

Inactivation of Various Variant Types of SARS-CoV-2 by Indoor-light-sensitive TiO_2-based Photocatalyst

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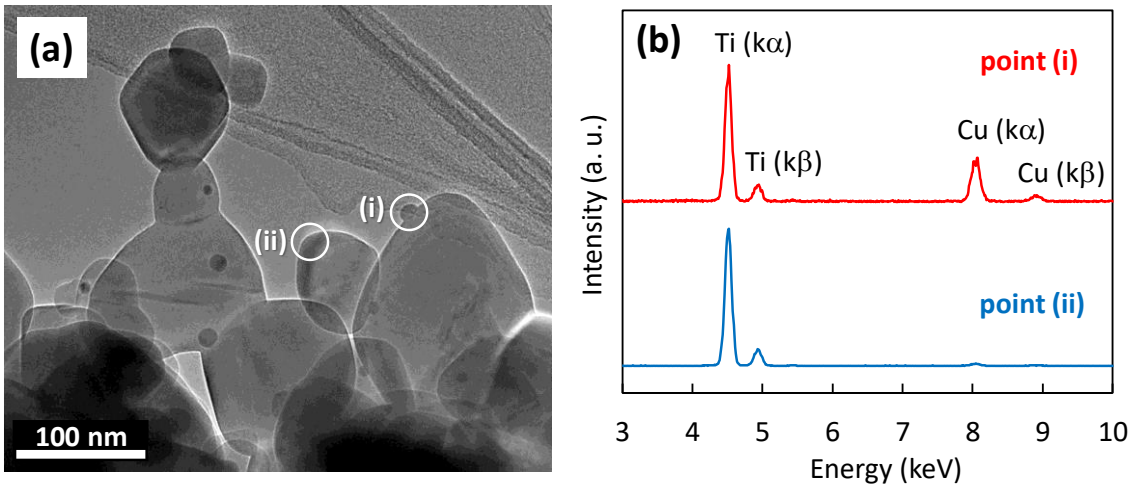

Fig. 1 TEM image and EDS analysis on Cu_xO/TiO_2. (a) TEM image and (b) EDS analysis on the points (i) and (ii) in the panel (a).

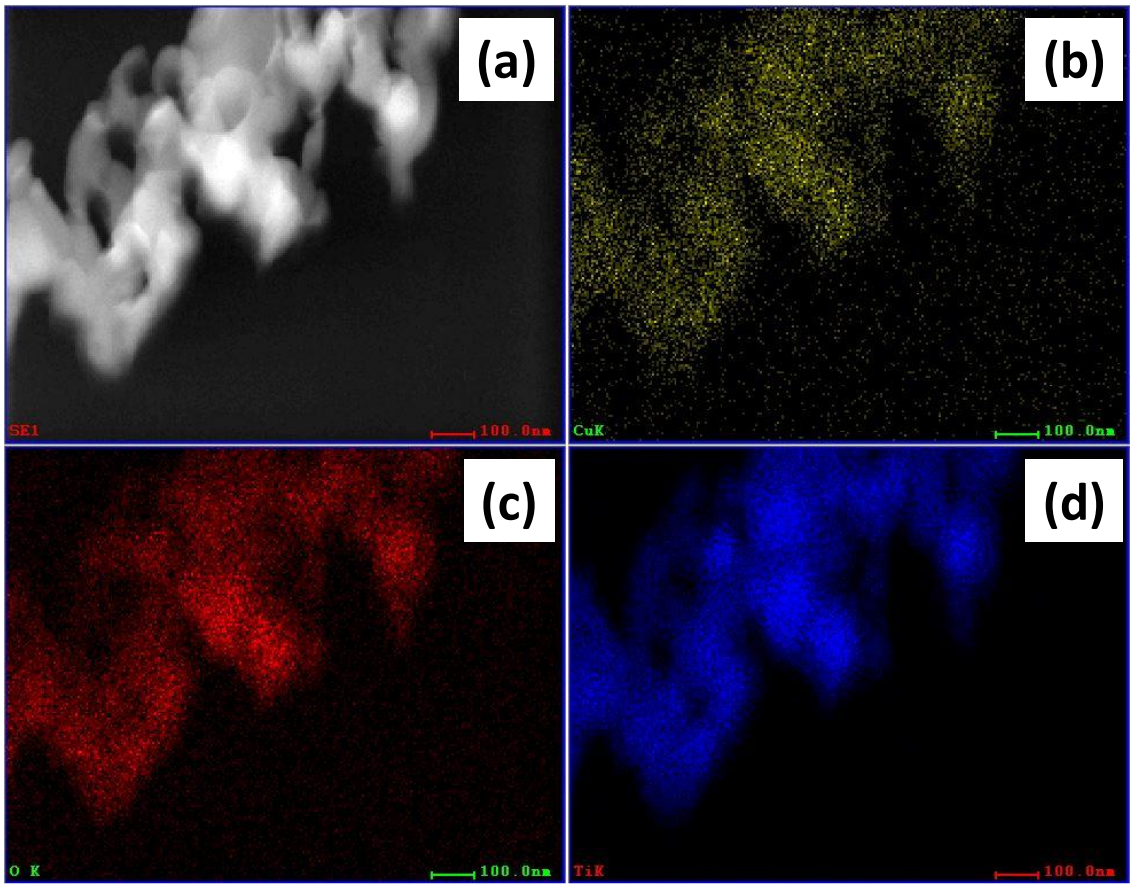

Fig. 2 FE-SEM image and its EDS mapping of Cu_xO/TiO_2. (a) SEM image, (b)-(d) EDS mapping images for copper (yellow), oxygen (red), and titanium (blue), respectively.

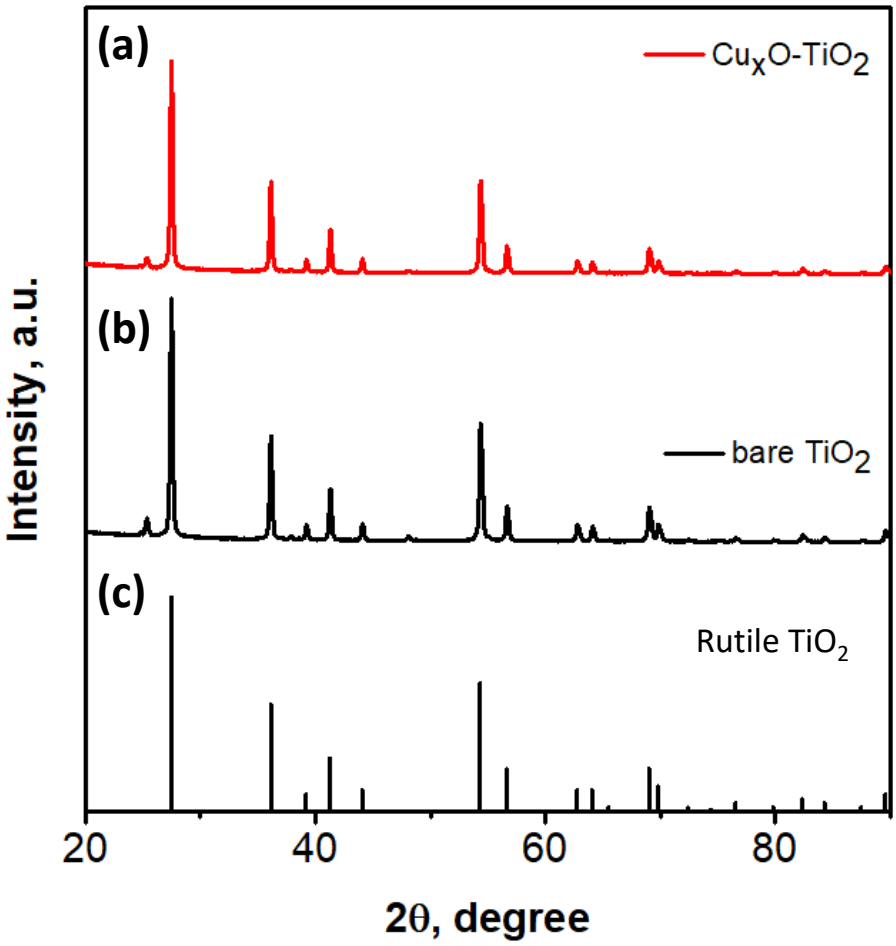

Fig. 3 XRD patterns. (a) Cu_xO/TiO_2, (b) TiO_2, and (c) reported diffraction pattern of TiO_2 in International Centre for Diffraction Data (ICDD File No. 03-065-1118).

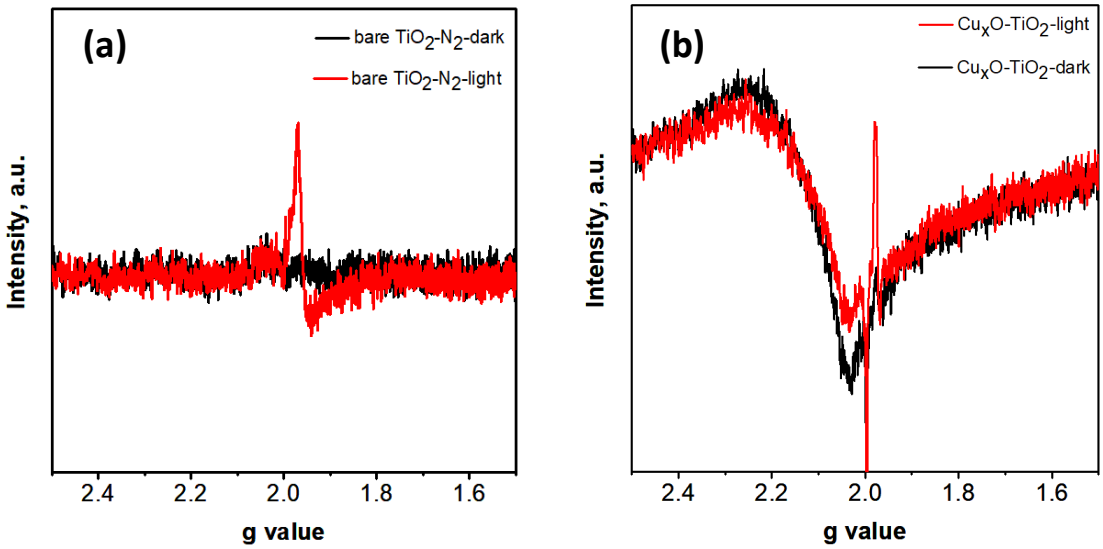

Fig. 4 ESR spectra under dark and visible light irradiation. (a) bare TiO_2 and (b) Cu_xO/TiO_2.

These spectra were recorded under nitrogen condition at 90 K. Sharp signals appeared in both panels at g= 1.98 under visible light irradiation are originated in photo-generated holes in the valence band of TiO_2 (c.f. Nosaka et al. *J. Phys. Chem. C*, 115, 21283, 2011). In the case of Cu_xO/TiO_2, broad signal appeared in the g value from 1.7 to 2.5, which is assigned to the Cu(II) species (c. f. Yin et al. *ACS Nano*, 9, 2111, 2015). Interestingly, the signal of Cu(II) species decreased under visible light irradiation, indicating the formation of Cu(I) species, while holes in the valence band of TiO_2 were generated. These results strongly imply that the IFCT transition proceeds in Cu_xO/TiO_2 *i. e.* electrons in the valence band of TiO_2 are excited to the Cu(II) species under visible light irradiation.

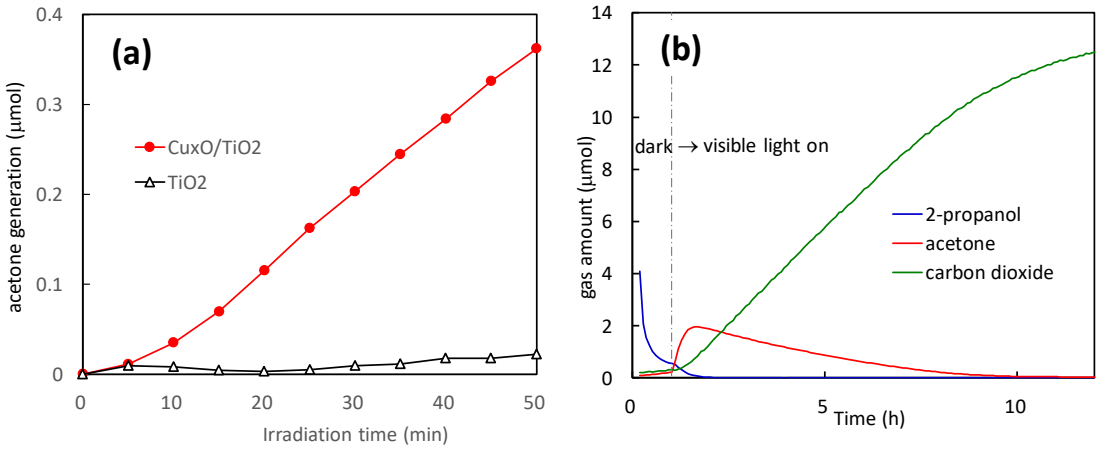

Fig. 5 Photocatalytic oxidation activity of Cu_xO/TiO_2 for the decomposition of gaseous 2-propanol under visible light irradiation. (a) acetone generation from bare TiO_2 and Cu_xO/TiO_2 under blue light emission diode (LED) irradiation, and (b) the time course of 2-propanol, acetone, and carbon dioxide amounts under visible light irradiation using a xenon lamp passed through a UV cutoff filter below 420 nm.

In the case of Cu_xO/TiO_2, 2-propanol was oxidized to acetone under blue LED, whereas the bare TiO_2 did not generate acetone. The panel (b) shows the changes of 2-propanol, acetone, and carbon dioxide amounts under the visible light irradiation over the Cu_xO/TiO_2 photocatalyt. The initial concentration of 2-propanol molecules was 4.1 μmol, which were oxidized to acetone, and further oxidized to carbon dioxide more than 12 μmol. It is noted that a 2-propanol molecule consists of three carbon atoms, thus the present photocatalysis result proves complete oxidation of 2-propanol into carbon dioxide under visible light irradiation over the Cu_xO/TiO_2 photocatalyt.

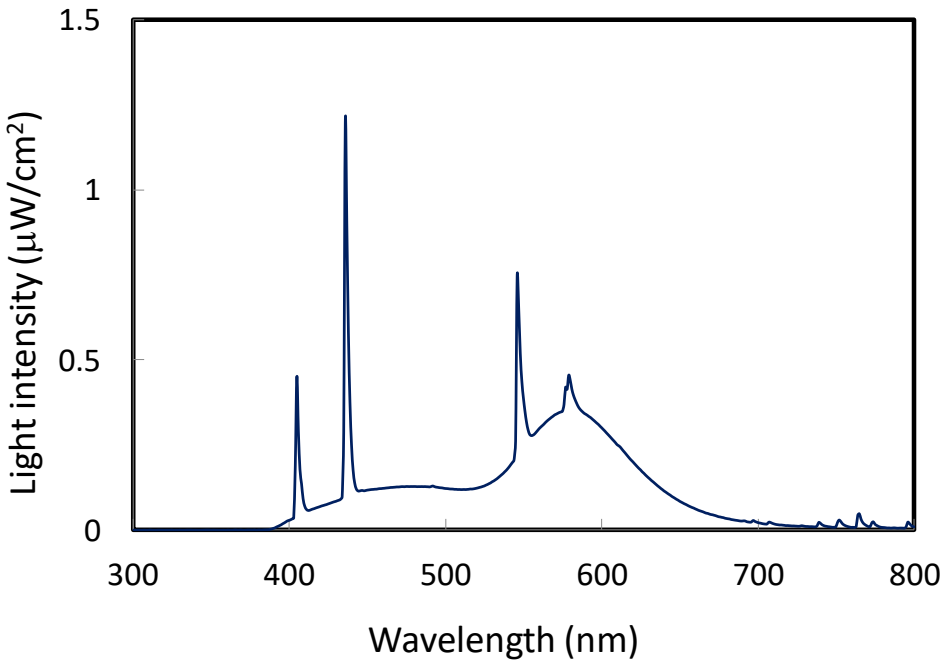

Fig. 6 Spectrum of visible light for the antiviral test. Light irradiation was performed using a white fluorescent light bulb passed through a UV cutoff filter. The light intensity of this spectrum was 1000 lx.

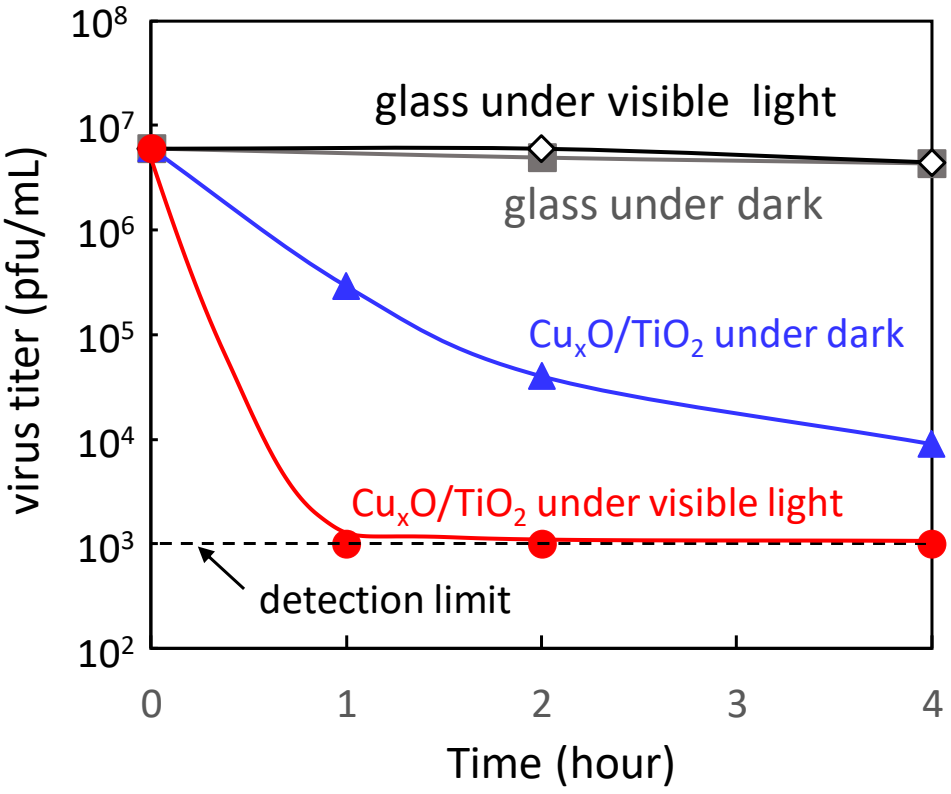

Fig. 7 Inactivation of feline calicivirus (FCV). Changes of virus titer of FCV viruses. Visible light irradiation was conducted using a white fluorescence bulb passed through a UV cutoff filter with the light intensity of 1000 lx.

Ames test

The Ames test [1)] has been conducted according to Organization for Economic Cooperation and Development (OECD) Guideline No. 471 (OECD 1987). [2)] The tester strains used in the Ames test were *Salmonella typhimurium* TA98, TA100, TA1535, TA1537 and *Escherichia coli* WP2*uvr*A. Five different concentrations of Cu_xO/TiO_2 (78.1, 156, 313, 625, and 1250 μg per plate) were dispersed and shaken at 37 °C for 20 mins with or without S9 mix. The positive controls employed for the assay were 2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide (AF-2), Sodium azide (SAZ), Benzo[a]pyrene (B[a]P), 2-Methoxy-6-chloro-9-[3-(2-chloroethyl)-aminopropylamino]acridine·2HCl (ICR-191), and 2-Aminoanthracene (2AA), respectively.

The results are shown in Table 1 (without S9 mix) and Table 2 (with S9 mix). The highest concentration of Cu_xO/TiO_2 in this test was 1250 μg per plate, and these conditions did not significantly induce any more colonies than the negative controls. These results reveal that the Cu_xO/TiO_2 exhibited the negative response in all cases suggesting its low genotoxic risk.

References,

1) D. M. Maron, B. N. Ames. Revised methods for the Salmonella mutagenicity test. *Mutat. Res.* **113**, 173–215 (1983).

2) OECD Guideline for Testing of Chemicals: Bacterial Reverse Mutation Test (1987).

Table 1 Ames test results without S9 mix (number of colonies per plate)

strain	TA100	TA1535	WP2*uvr*A	TA98	TA1537
negative control (DMSO)	81 91 75 (82±8.1)	13 11 16 (13±2.5)	13 11 11 (12±1.2)	13 22 23 (19±5.5)	13 11 8 (11±2.5)
78.1 μg	80 87 89 (85±4.7)	6 15 10 (10±4.5)	15 9 13 (12±3.1)	19 24 13 (19±5.5)	6 7 10 (8±2.1)
156 μg	121 94 81 (99±20.4)	9 12 8 (10±2.1)	13 10 10 (11±1.7)	25 20 21 (22±2.6)	10 6 11 (9±2.6)
313 μg	79 99 89 (89±10.0)	7 14 7 (9±4.0)	8 11 11 (10±1.7)	27 17 21 (22±5.0)	9 4 9 (7±2.9)
625 μg	106 76 86 (89±15.3)	5 14 12 (10±4.7)	18 15 12 (15±3.0)	15 15 23 (18±4.6)	6 5 9 (7±2.1)
1250 μg	83 91 90 (88±4.4)	10 10 13 (11±1.7)	11 10 14 (12±2.1)	22 24 22 (23±1.2)	7 10 8 (8±1.5)
positive chemical	**AF-2**	**SAZ**	**AF-2**	**AF-2**	**ICR-191**
dose	0.01μg/plate	0.5μg/plate	0.01μg/plate	0.1μg/plate	1.0μg/plate
	722 724 721 (722±1.5)	302 321 325(316±12.3)	80 92 62 (78±15.1)	420 402 384(402±18.0)	905 819 953(892±67.9)

Table 2 Ames test results with S9 mix (number of colonies per plate)

strain	TA100	TA1535	WP2*uvr*A	TA98	TA1537
negative control (DMSO)	104 106 98 (103±4.2)	18 13 12 (14±3.2)	15 16 19 (17±2.1)	25 24 29 (26±2.6)	17 15 13 (15±2.0)
78.1 μg	120 110 103 (111±8.5)	10 11 12 (11±1.0)	18 20 21 (20±1.5)	21 27 24 (24±3.0)	10 12 12 (11±1.2)
156 μg	106 114 92(104±11.1)	9 12 13 (11±2.1)	12 8 13 (11±2.6)	33 34 25 (31±4.9)	13 13 16 (14±1.7)
313 μg	62 103 71 (79±21.5)	8 12 13 (11±2.6)	12 13 15 (13±1.5)	21 27 20 (23±3.8)	6 10 10 (9±2.3)
625 μg	92 86 82 (87±5.0)	13 11 13 (12±1.2)	13 16 8 (12±4.0)	33 20 30 (28±6.8)	7 9 10 (9±1.5)
1250 μg	79 82 75 (79±3.5)	11 14 10 (12±2.1)	8 12 10 (10±2.0)	35 26 27 (29±4.9)	10 10 9 (10±0.6)
positive chemical	**B[a]P**	**2AA**	**2AA**	**B[a]P**	**B[a]P**
dose	5.0μg/plate	2.0μg/plate	10.0μg/plate	5.0μg/plate	5.0μg/plate
	897 895 937(910±23.7)	247 295 249(264±27.2)	881 892 748(840±80.2)	303 303 337(314±19.6)	91 100 87(93±6.7)