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Supporting documents

BiOClBr-coated Fabrics with Enhanced Antimicrobial Property under Ambient Light

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Experimental procedures to study bio-toxicity of BiOClBr microparticles and BiOClBr coated fabric

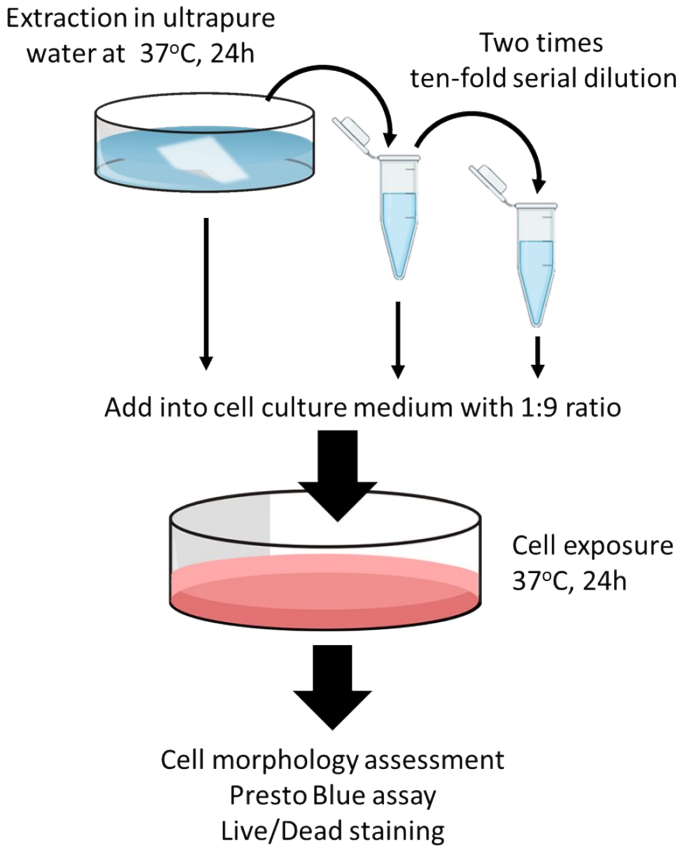
L929 mouse fibroblast cells (ATCC) were cultured in Dulbecco's Modified Eagle Medium (Gibco, USA) supplemented in 10% Fetal Bovine Serum (Gibco) and 1% Penicillin-Streptomycin solution (Gibco). Cells were grown in standard culture condition of 5% CO_2 at 37°C.

For the bio-toxicity test of BiOClBr microparticles, cells were seeded at a seeding density of 7,500 cells cm^{-2} the day before the particle exposure. BiOClBr microparticle stock suspension was freshly prepared in ultrapure water by introducing sonication energy of 353 J mL^{-1}. Thereafter, the microparticles were sterilized under UV irradiation for 30 minutes, and were further diluted in cell culture medium to reach a final concentration of 1, 2.5, 5, 10, 25, 50, 100, 250, 500 μg mL^{-1}. After particle exposure for 24 hours, the cells were washed once with PBS. Cell morphology was visualized with inverted microscope (Olympus IX53, Japan), and their viability was assayed with PrestoBlue Cell Viability Reagent (ThemoFisher, USA). Following 2 h of PrestoBlue solution incubation, the cell culture medium was collected and the PrestoBlue fluorescence signal was measured with a microplate reader (Tecan, Switzerland), in which the excitation and emission wavelengths were set at 560 and 590 nm, respectively. Ultrapure water was introduced as vehicle control to which the viability data were normalized.

Data were generated from three independent experiments with 4 biological replicates in each experiment and were fitted to a non-linear sigmoidal dose response function to determine the IC_{20}, IC_{50}, and IC_{80} values, i.e., respective concentrations producing 20%, 50% and 80% reduction of number viable cells. Median lethal dose (LD_{50}) value was then estimated by the following formula:

$$\log LD_{50}\ (\text{mg kg}^{-1}) = 0.372 \log IC_{50}\ (\mu\text{g mL}^{-1}) + 2.024.$$

The cytotoxicity of BiOClBr coated fabric was assessed *via* indirect exposure of sample extracts as described in ISO-10993-5:2009 standard procedure. Briefly, the L929 cells were seeded 24 hours prior to cytotoxicity study in 96-well plate at density of 10,000 cells/well. Following 24 hours of sample extracts incubation, the cells were washed once with PBS. Prior to extraction, uncoated and BioClBr-coated fabrics were weighed and sterilized under UV irradiation 30 min each sides. Thereafter the samples were added in sterile ultrapure water and the extraction was carried out for 24 hours at 37 °C using a weight/volume ratio of 0.1 g/ml according to ISO10993-12:2012. The original extracts thereafter were subjected to two times ten-fold serial dilutions. Sterile ultrapure water subjected to identical extraction condition was used the control group (blank control). Prior to introduction to the cells, the samples and blank control were added to sterile cell culture medium with volume ratio of 1 : 9. Positive control group received treatment of *tert*-Butyl hydroperoxide (Sigma; 1mM, 2 hours).



Cell morphology was again visualized with inverted microscope, and their viability was assayed with 2h incubation of PrestoBlue Cell Viability Reagent and measured with microplate reader. Thereafter, the cell membrane integrity was ascertained with LIVE/DEAD™ Viability/Cytotoxicity Kit (ThermoFisher), and the cell viability status was visualized with inverted fluorescence microscope.

Table S1 Analysis of O1s BE levels of BiOClBr-coated cotton

Sample	BE (eV)	Assignments
Cotton	531.29	adsorbed hydroxyl groups (OH-)
	532.79	oxygen species
BiOClBr	529.91	lattice oxygen of Bi–O bond of both BiOBr and BiOCl
	530.7	crystal lattice O atom of Bi–O
	531.92	adsorbed hydroxyl groups (OH-)
	533.29	oxygen species and water (H2O) on top
BiOClBr on cotton without polymeric binders	529.95	lattice oxygen of Bi–O bond of both BiOBr and BiOCl
	530.99	crystal lattice O atom of Bi–O
	532.68	oxygen species
BiOClBr on cotton with polymeric binders	530.56	crystal lattice O atom of Bi–O
	532.13	oxygen species
	535.13	Na KLL Auger

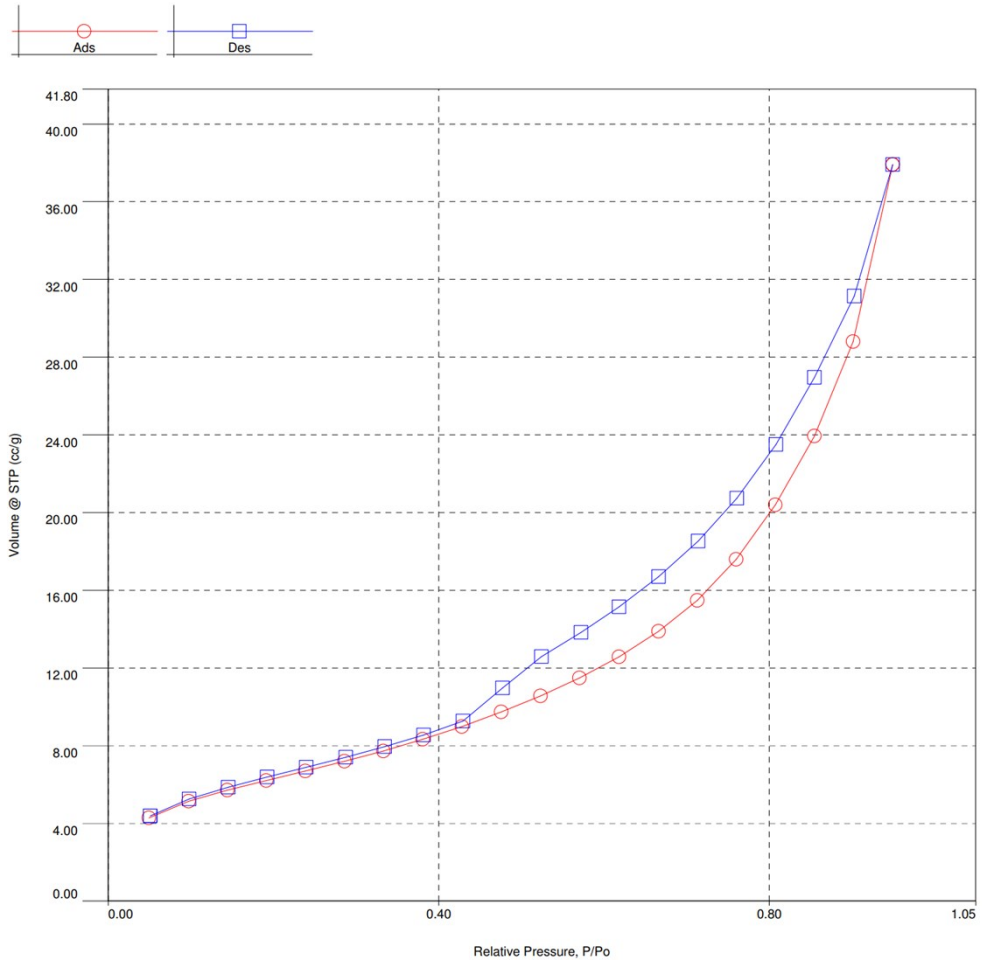


Fig. S1 Nitrogen adsorption and desorption isotherms of BiOClBr at 77k.

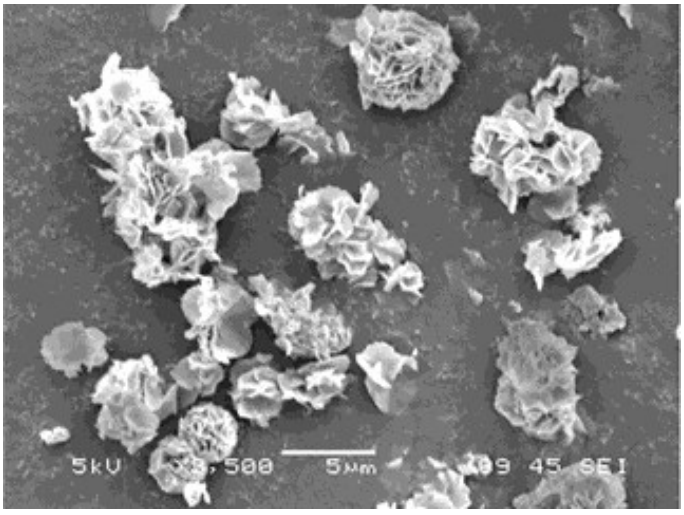


Fig. S2 Morphologies of BiOClBr synthesized without utilization of probe sonication during addition of CTAC and CTAB. Scale bar is 5µm.

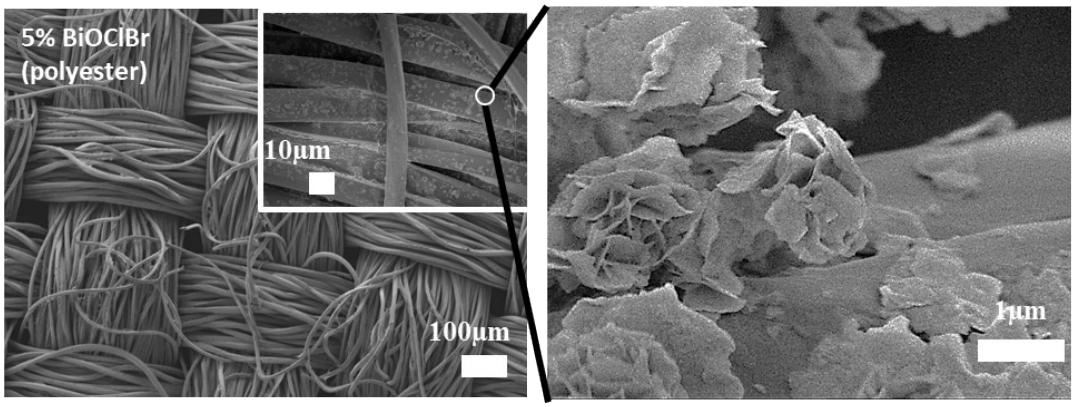


Fig. S3 Surface morphologies of 5% BiOClBr-coated polyester.

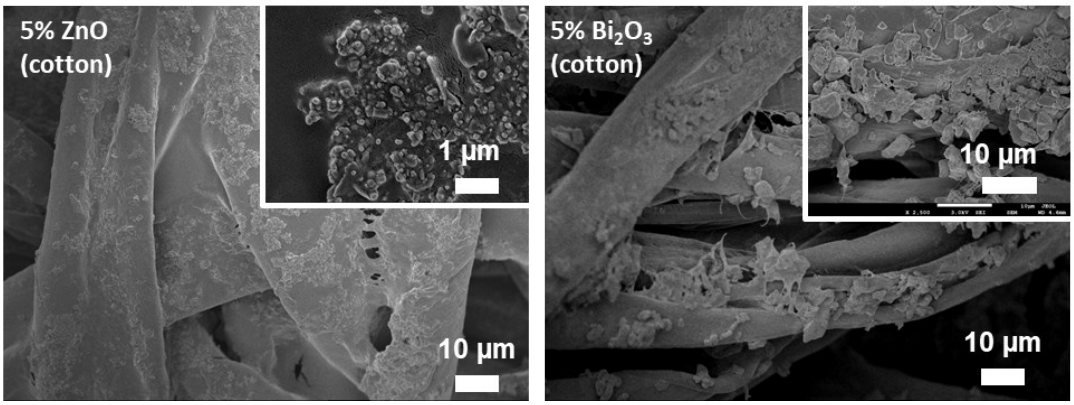


Fig. S4 Surface morphologies of 5% ZnO-coated and Bi_2O_3-coated cotton.

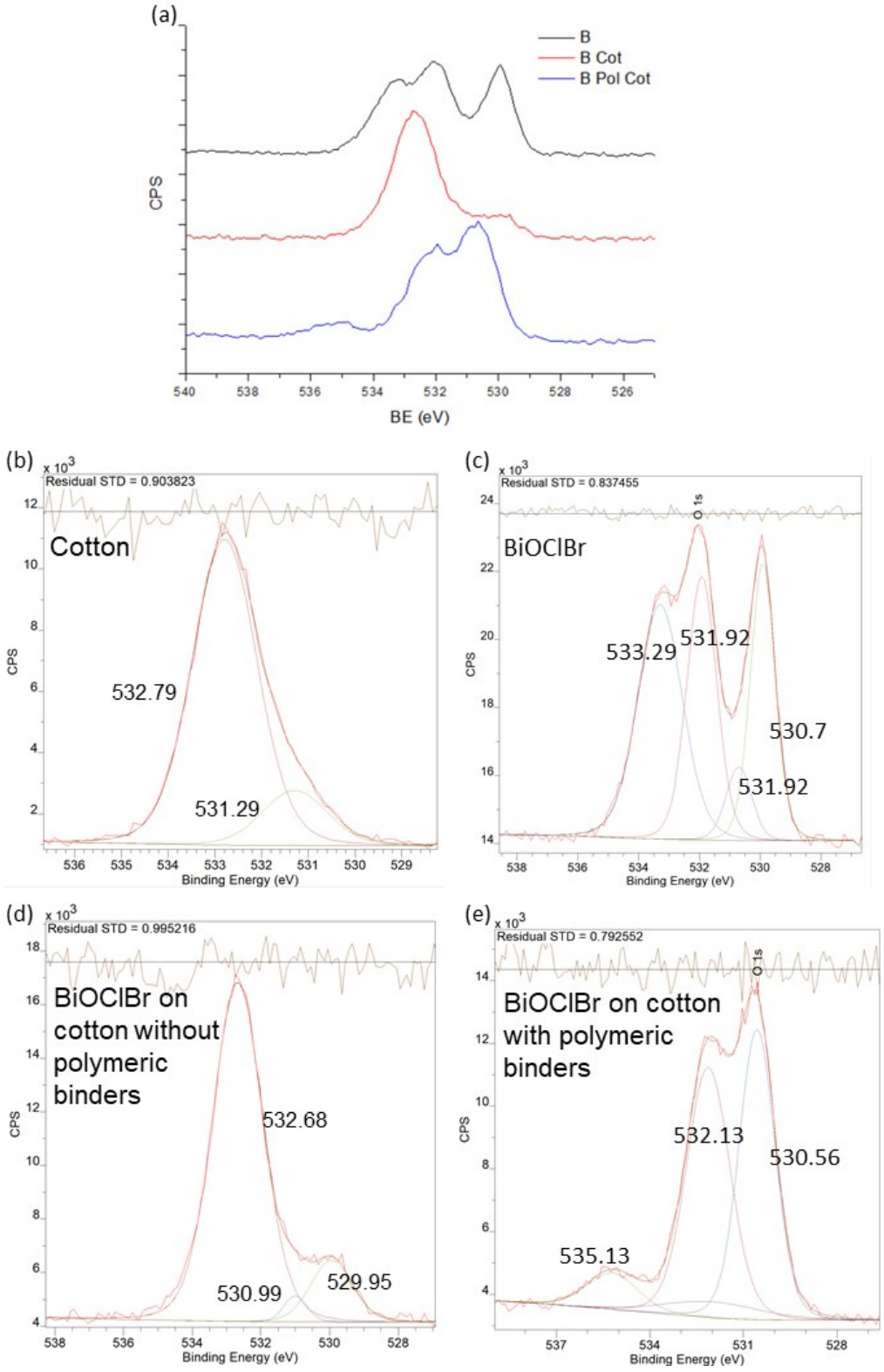


Fig. S5 (a) O1s BE levels of measured BiOClBr at different conditions (*Cot*: cotton; B: BiOClBr; *B Cot*: BiOClBr on cotton without binders; *B Pol Cot*: BiOClBr on cotton with binders), together with analysis of O1s BE levels of (b) cotton, (c) BiOClBr, (d) BiOClBr on cotton without polymeric binders, and (e) BiOClBr on cotton with polymeric binders.

Antimicrobial testing for BiOClBr coated fabric after soap washing

Table S2 LRV performance of different fabric conditions after soap washing

Samples	CFU	LRV
Non-coated fabric without washing	1.2×10^6	-
Coated fabric without washing	< 20 ~ 0	~6
Non-coated fabric (immersed in 0.05% soap and washing)	1.14×10^6	-
Non-coated fabric (immersed in 0.1% soap and washing)	9.2×10^4	1.12
Coated fabric (immersed in 0.05% soap and washing)	< 20 ~ 0	~6
Coated fabric (immersed in 0.1% soap and washing)	1.16×10^3	3.014

Below are the procedures used for the test:

(1) Immersion of fabric samples in soap solution for 10 min by shaking
(2) Washing fabric samples with sterilized deionized water for three times
(3) Immersion of fabric samples in bacteria suspension for 24 h
(4) Spread plate and incubation for 18 h

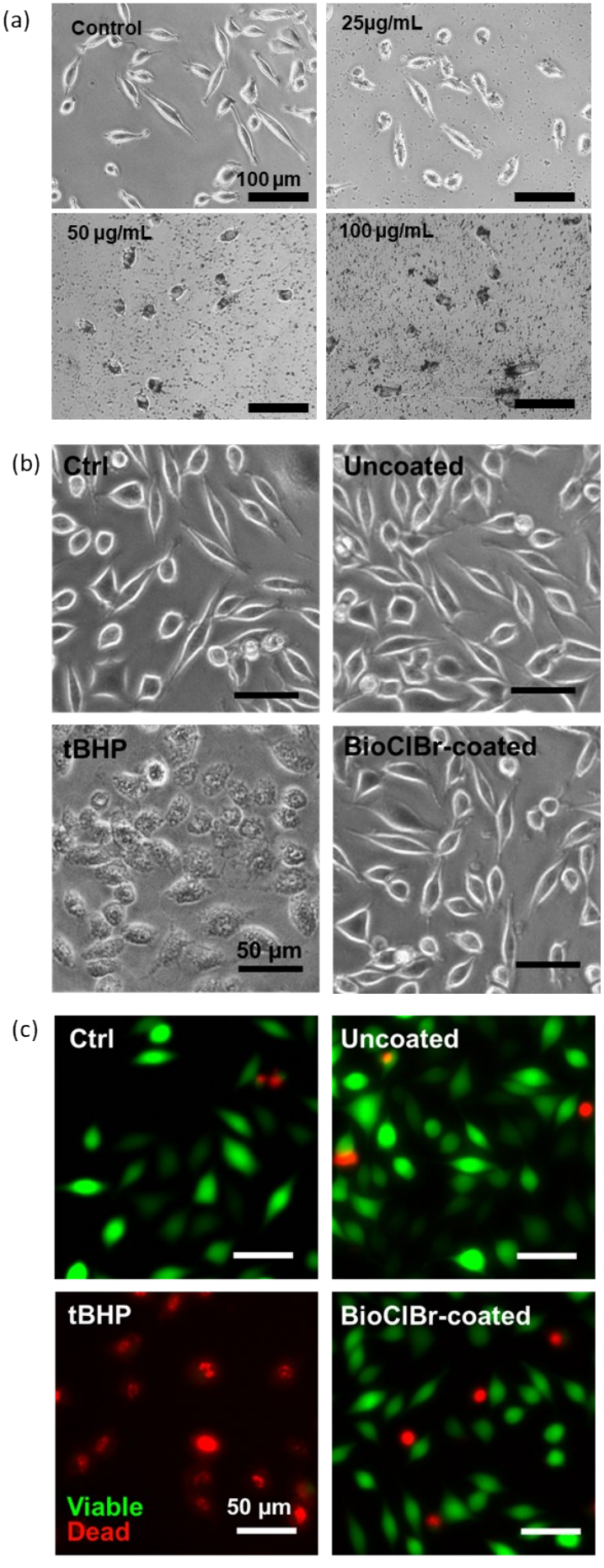


Fig S6 (a) Phase contrast microscope images that shows the change in L929 cells' morphology after exposure to BiOClBr particles of different concentrations for 24 h. Scale bar: 100 µm. (b) Phase contrast microscope images show no change in L929 cells' morphology following 24h exposure to extract of BiOClBr-coated fabric. Scale bar: 50 µm. (c) fluorescence images confirm minimum cytotoxicity following 24h exposure to extract of BiOClBr-coated fabric. Scale bar: 50 µm. Images shown are representative of three independent experiments.

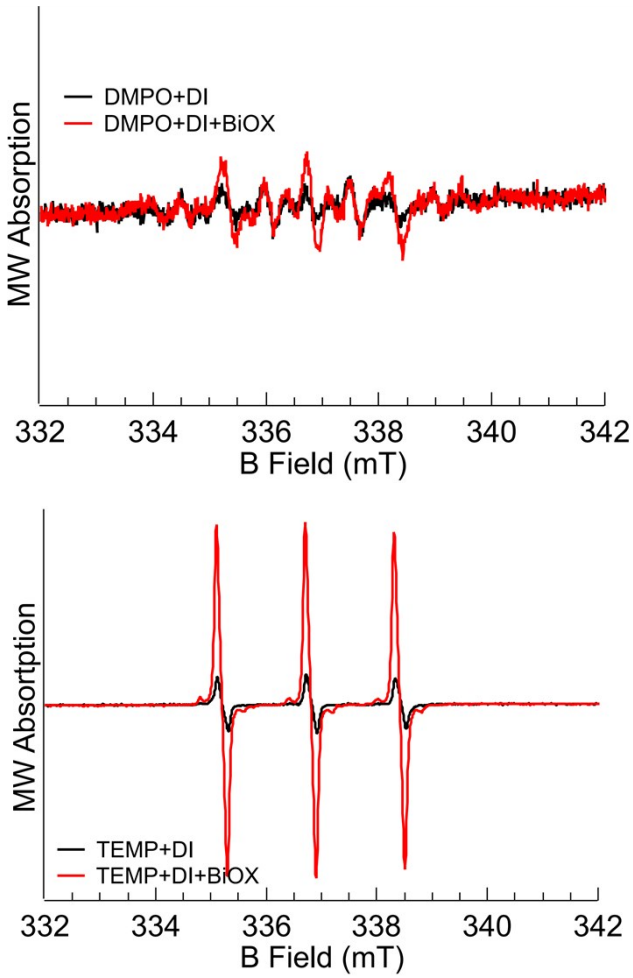


Fig. S7 EPR of BiOClBr microparticles with DMPO and TEMP as spin trapping agents.

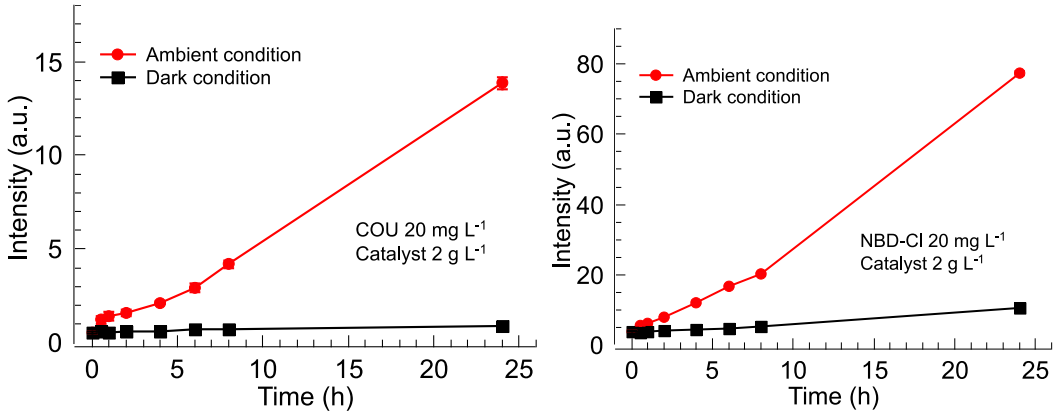


Fig. S8 Determination of hydroxyl radical and superoxide generation in ambient condition in the presence of BiOClBr microparticles *via* the fluorescence spectrometer.

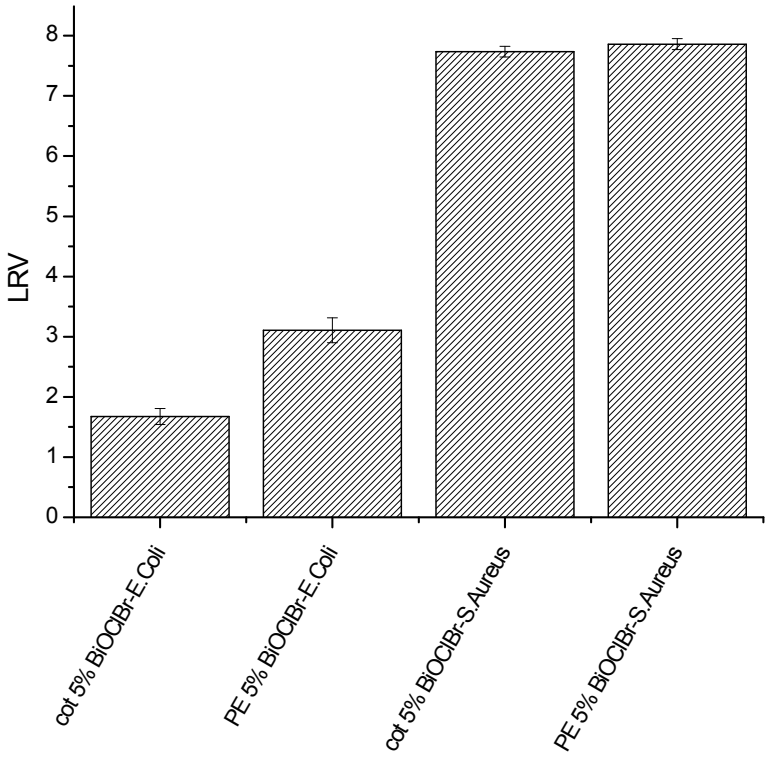


Fig. S9 Antimicrobial properties against 10^8 CFU mL^{-1} *E. coli* and *S. aureus* of the coated cotton and polyester fabric with 5% BiOClBr microparticles.