

# Inactivation and Degradation of Influenza A Virus on the Surface of Photoactive Self-Cleaning Cotton Fabric Functionalized with Nanocrystalline TiO<sub>2</sub>

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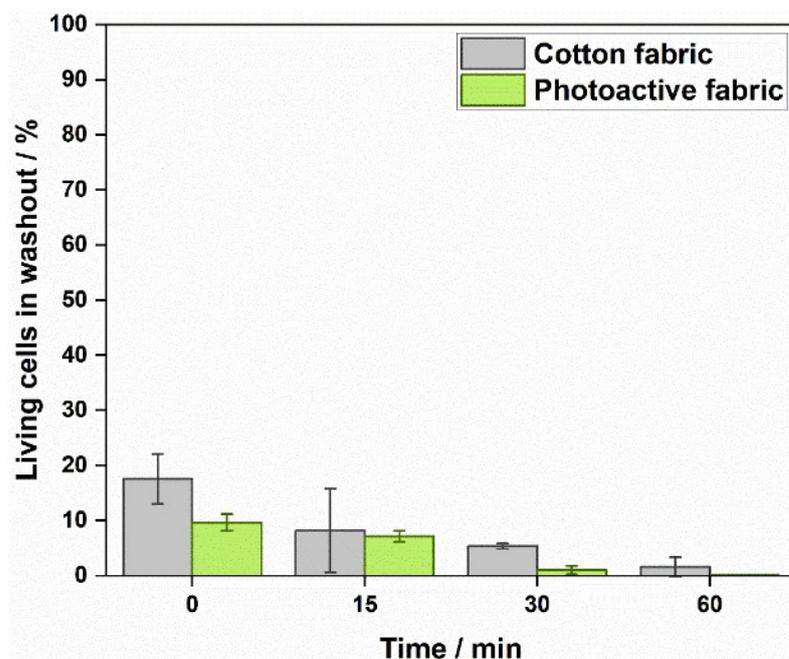
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## Supplementary

### 1. Adsorption of *Escherichia coli* on cotton fabrics

The adsorption capacity of cotton-based materials was investigated using the night culture of *E. coli* bacteria (ATCC 25922). Cotton fabric had area density of 350 g·m<sup>-2</sup>. In addition to initial cotton, the photoactive cotton fabric modified with TiO<sub>2</sub> photocatalyst was used to estimate the effect of titanium dioxide on adsorption. Concentration of bacterial cell was estimated as a number of colony forming units (CFU) in 1 mL of suspension. For these experiments, small pieces with an area of 1 cm<sup>2</sup> were cut from both fabrics and autoclaved at 120 °C for 30 min for the sterilization. A 10-μL aliquot of bacterial suspension (~5·10<sup>6</sup> CFU·mL<sup>-1</sup>) was dropped on pieces of fabric followed by incubation for 0, 15, 30, or 60 min to analyze the kinetics of adsorption. After that, each piece was transferred into tube with 5 mL of saline. All tubes were vigorously shaken to rinse out the cells from the surface of fabric pieces. The number of living cells was determined by serial dilution with plating on Luria Bertani (LB) agar plates. After incubation at 37 °C overnight, concentration of bacterial cells (CFU·mL<sup>-1</sup>) was determined according a standard technique. The number of cells in washout was divided in the total number of cells in initial suspension and multiplied by 100% to evaluate the adsorption capacity of materials. The experiments were repeated at least three times to estimate the error as the standard deviation.

Even short incubation of bacterial suspension on the surface of cotton fabrics led to a strong decrease in the number of cells in washouts (Figure S1). After 15 min of incubation, the materials adsorbed more than 90% of *E. coli* cells. It is important to note that nanocrystalline TiO<sub>2</sub> used for modification of cotton substantially enhanced the adsorption of bacteria. Further increase in the incubation time led to the complete adsorption of almost all cells on both fabrics. These experiments show a high adsorption capacity of cotton substrate used for functionalization with TiO<sub>2</sub>. The data correlate with the results for influenza virus in the case of virus suspension with a low concentration of protein (see Figure 3c in the main part of article).

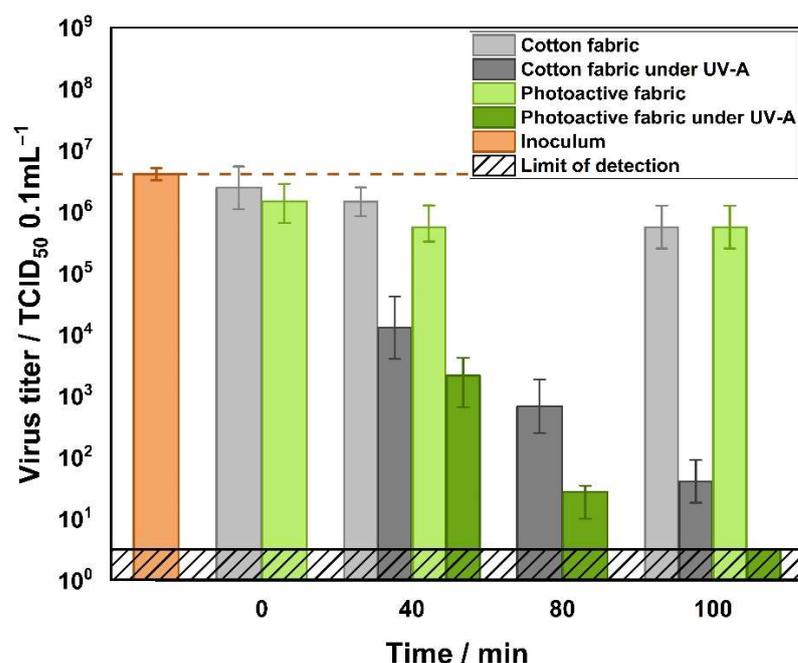


**Figure S1.** Adsorption kinetics of *E. coli* cells on the surface of cotton and photoactive fabrics.

## 2. Inactivation of influenza A virus

In addition to the data shown in Figure 3a and b, a time required for complete inactivation of influenza virus for the case of virus suspension contained  $10 \text{ mg L}^{-1}$  of proteins was estimated under the same conditions, as described in the main text of article. Briefly, a  $50\text{-}\mu\text{L}$  aliquot of virus suspension contained  $10 \text{ mg mL}^{-1}$  of proteins was dropped on small pieces of cotton or photoactive fabrics. Contaminated samples were irradiated with UV-A light ( $370 \text{ nm}$ ,  $8 \text{ mW cm}^{-2}$ ) for 0, 40, 80, and 100 min. The control experiments were performed similarly without UV irradiation to check the stability of virus. Then, each piece was transferred into tube with  $10 \text{ mL}$  of Dulbecco's Phosphate-Buffered Saline (DPBS). All tubes were vigorously shaken to rinse out the virus and stored on ice during the day of experiment. The concentration of virus in washouts was evaluated by method of Median Tissue Culture Infectious Dose ( $\text{TCID}_{50}$ ) using Madin-Darby Canine Kidney (MDCK) cells. All samples were incubated at  $37 \text{ }^{\circ}\text{C}$  and  $5 \text{ \% CO}_2$  for three days. The infected wells were determined by hemagglutination. The virus titer for all cases was calculated using the Reed-Muench method.

Irradiation of both contaminated fabrics with UV-A light led to a monotonic decrease in the virus titer, while the incubation without irradiation had no substantial impact on the infectivity of virus. (Figure S2). After 100 min of irradiation, the influenza virus was completely inactivated on the surface of photoactive fabric because the detection limit of  $\text{TCID}_{50}$  method was achieved in this case. At the same time, the detected value of virus titer for pristine cotton was  $10^{1.6} = 40$  that indicates an incomplete inactivation of virus for cotton fabric without photoactive component. An extra time was required to completely inactivate all virus particles. Therefore, the synthesized photoactive cotton fabric can provide a faster inactivation of influenza A virus compared to pristine cotton that shows its potential for application in biochemical and medical labs as self-cleaning material.



**Figure S2.** Dependence of virus titer on incubation time of contaminated cotton and photoactive fabrics without and with UV irradiation. Concentration of proteins in inoculum corresponds to 10 mg·mL<sup>-1</sup>.

### 3. Degradation of influenza A virus on the surface of cotton-rich fabric functionalized with N-doped TiO<sub>2</sub>

N-doped TiO<sub>2</sub> (TiO<sub>2</sub>-N) photocatalyst was prepared via the precipitation method using titanyl sulfate as a titanium precursor and ammonium hydroxide as a precipitating agent at pH = 7. White precipitate formed after mixing the reagents was stirred in mother liquor for several days for aging followed by washing and calcination in air at 350 °C.

Visible-light active textile was obtained via the impregnation of washed cotton-rich fabric with a size of 9 × 9 cm<sup>2</sup> using the suspension of Ti(OC<sub>3</sub>H<sub>7</sub>)<sub>4</sub> and milled N-doped TiO<sub>2</sub> (10 g·L<sup>-1</sup>) in isopropyl alcohol (AO Reachem Inc., Moscow, Russia) followed by the treatment with water steam and drying in air at 110 °C.

The degradation of influenza A virus on the surface of prepared photoactive fabric and pristine cotton fabric was investigated under blue light (450 nm) using the PCR technique by similar way, as described in the main text of manuscript. Figure S3 shows the effect of irradiation time on a decrease in the concentration of virus RNA for both materials. In contrast to pristine cotton fabric, the concentration of detected RNA molecules was monotonically decreased on the surface of photoactive fabric during the irradiation with blue light. with under visible light.

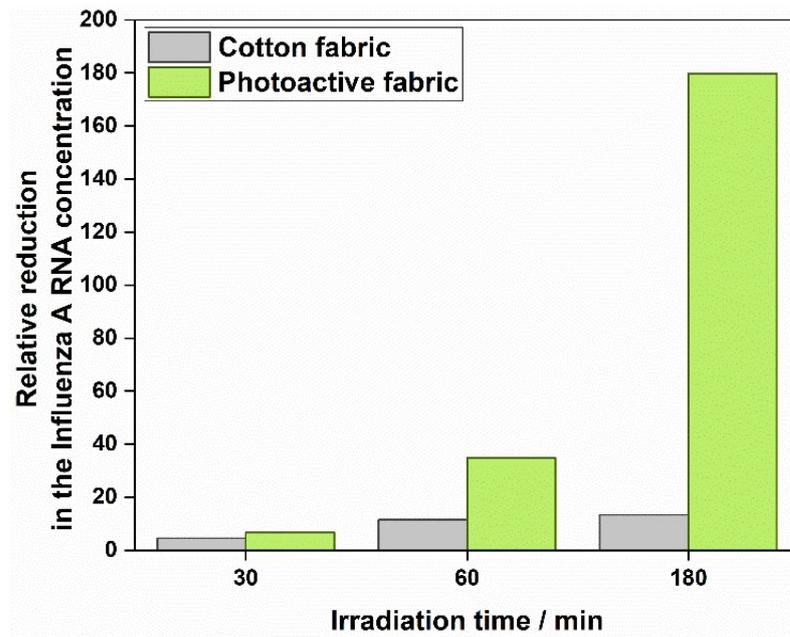


Figure S3. Relative reduction in the concentration of virus RNA during the irradiation of photoactive and cotton-rich fabrics with blue light.