

Electronic Supplementary Information for

**Engineering surgical face masks with photothermal and photodynamic plasmonic nanostructures for enhancing filtration and on-demand pathogen eradication**

Mohammad Ali Haghighat Bayan,<sup>1</sup> Chiara Rinoldi,<sup>1</sup> Daniel Rybak,<sup>1</sup> Seyed Shahrooz Zargarian,<sup>1</sup> Anna Zakrzewska,<sup>1</sup> Olga Cegielska,<sup>2</sup> Kaisa Pöhako-Palu,<sup>3</sup> Shichao Zhang,<sup>4</sup> Agata Stobnicka-Kupiec,<sup>5</sup> Rafał L. Górny,<sup>5</sup> Paweł Nakielski,<sup>1</sup> Karin Kogermann,<sup>3</sup> Luciano De Sio,<sup>6</sup> Bin Ding,<sup>4</sup> and Filippo Pierini<sup>1\*</sup>

<sup>1</sup>Department of Biosystems and Soft Matter, Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw 02-106, Poland

<sup>2</sup>Laboratory of Polymers and Biomaterials, Institute of Fundamental Technological Research Polish Academy of Sciences, Warsaw 02-106, Poland

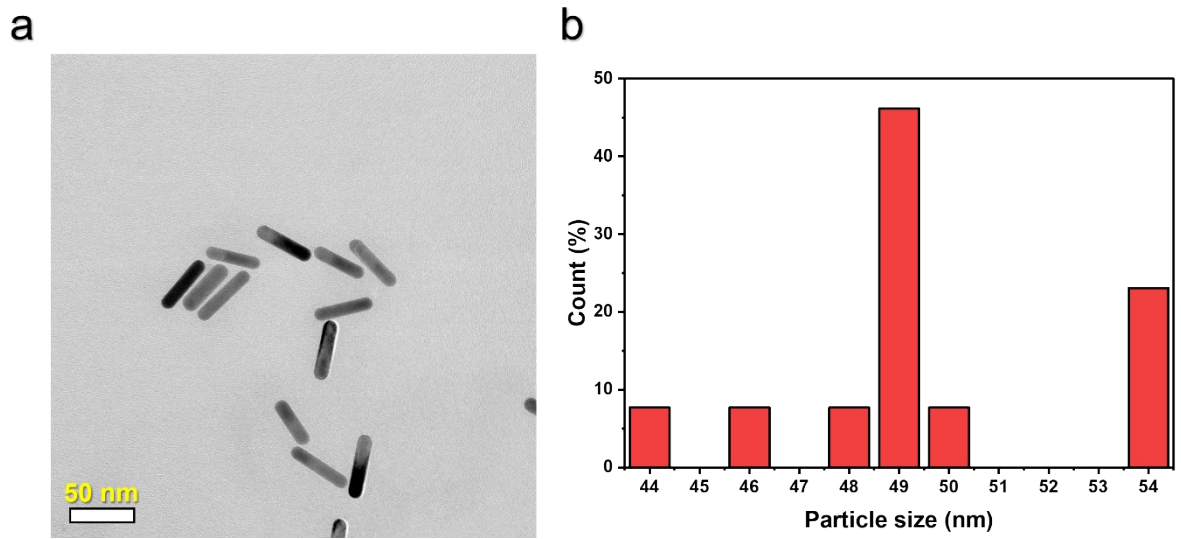
<sup>3</sup>Institute of Pharmacy, Faculty of Medicine University of Tartu, Nooruse 1, 50411 Tartu, Estonia

<sup>4</sup>Innovation Center for Textile Science and Technology, College of Textiles, Donghua University, Shanghai 201620, China

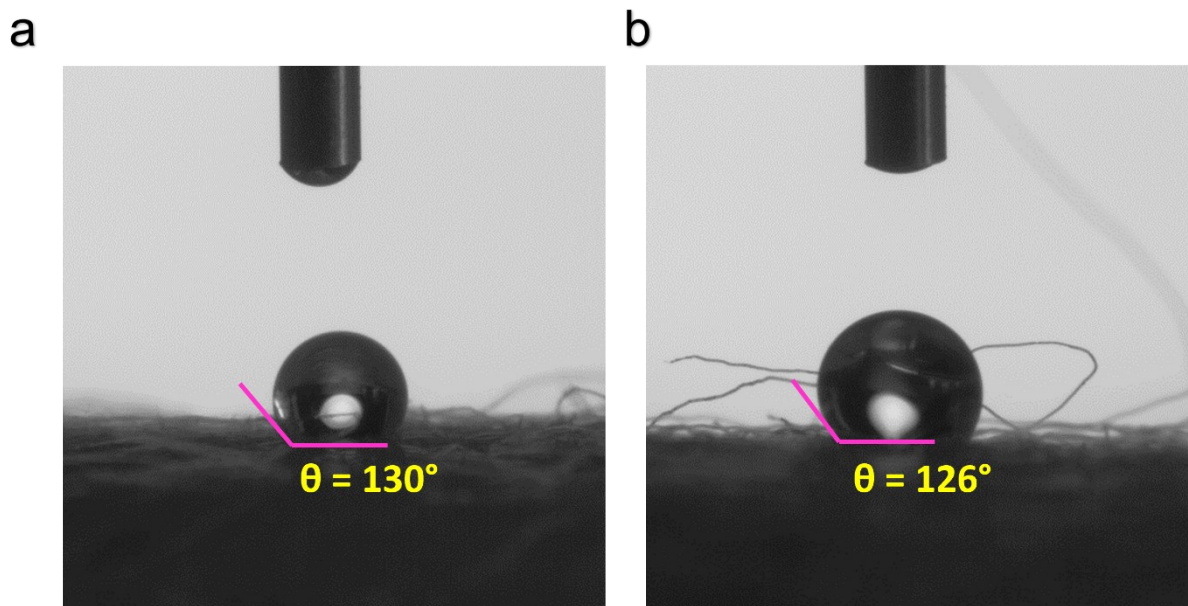
<sup>5</sup>Laboratory of Biohazards, Department of Chemical, Aerosol and Biological Hazards, Central Institute for Labour Protection – National Research Institute, Warsaw 00-701, Poland

<sup>6</sup>Department of Medico-Surgical Sciences and Biotechnologies, Research Center for Biophotonics, Sapienza University of Rome, Latina 04100, Italy

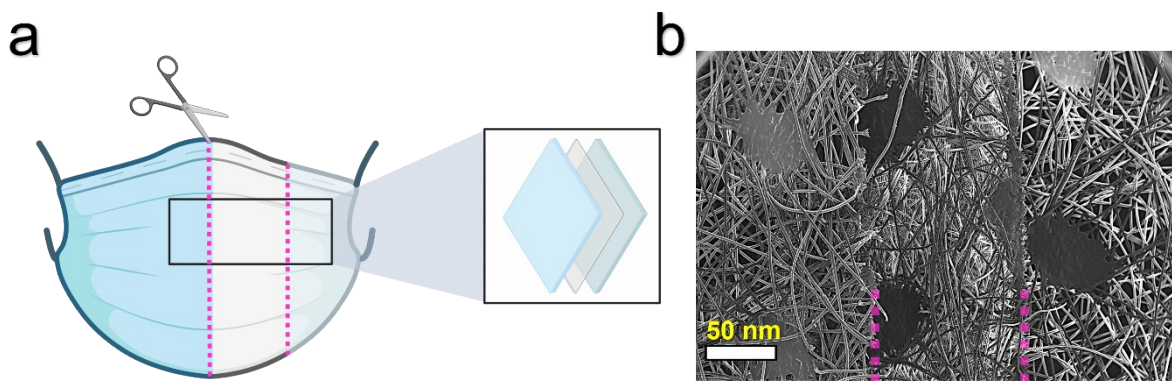
\*Corresponding author. E-mail: [fpierini@ippt.pan.pl](mailto:fpierini@ippt.pan.pl)



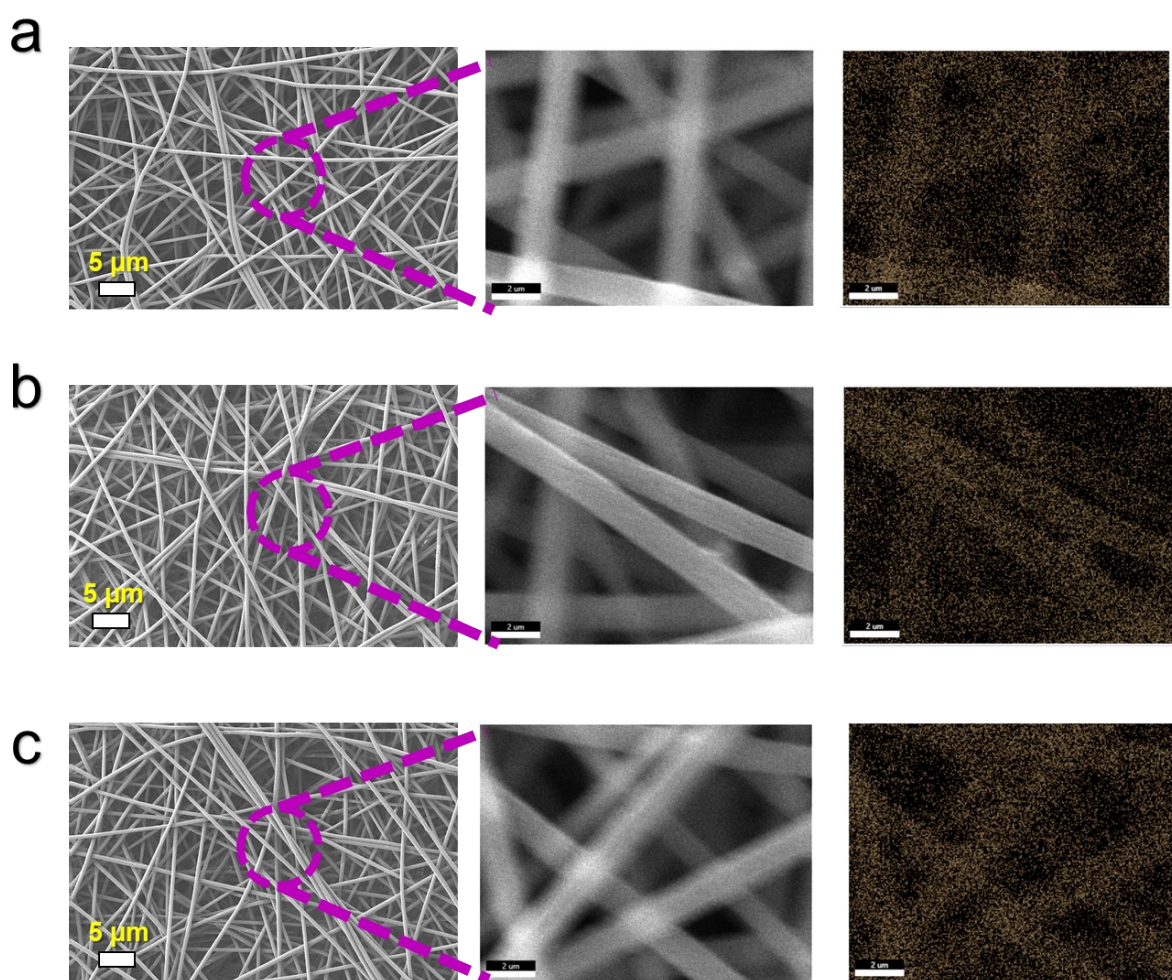
**Fig. S1** a) TEM image of gold nanorods (Au NRs) and b) particle size distribution of measured Au NRs.



**Fig. S2** Contact angle measurements of a) surgical mask and b) nanostructured face mask, showing the hydrophobicity of both masks.

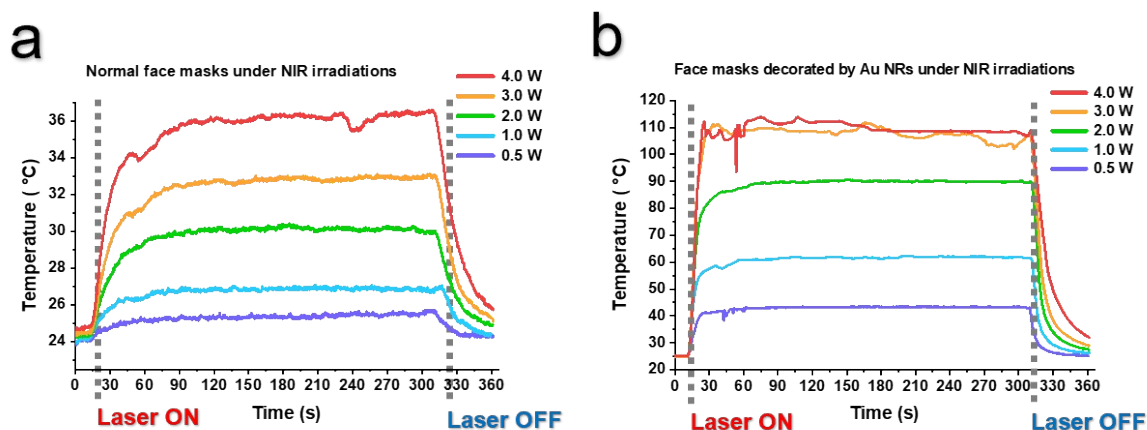


**Fig. S3** a) schematic of three-layer surgical face mask and b) related SEM image of surgical mask layers.

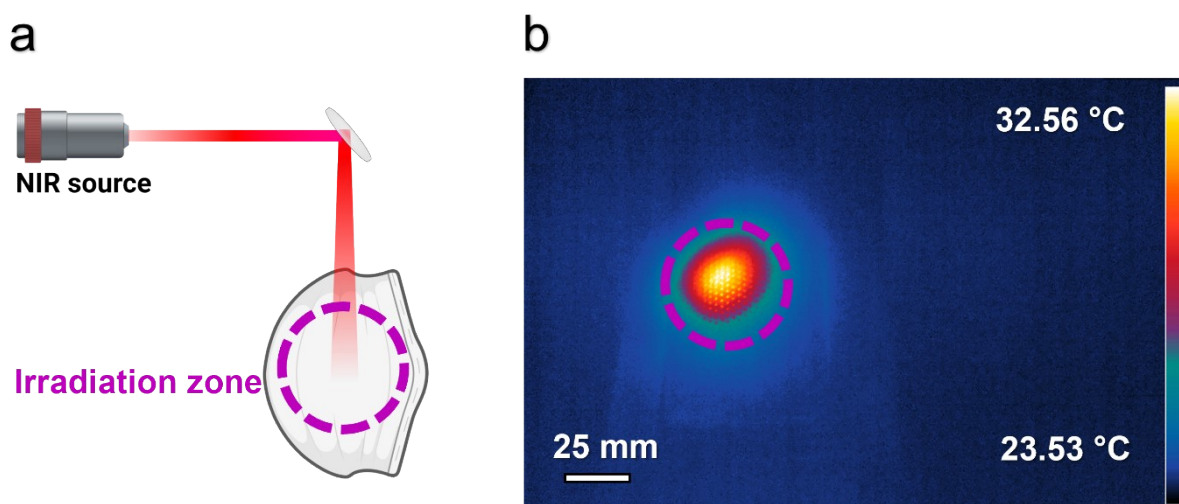


**Fig. S4** FE-SEM image, and Au EDX map of decorated nanofibers with Au nanoparticles. Images have been taken from corners and the center of the decorated nanofibers. The mapping images show the distribution of gold nanoparticles along the different places in the electrospayed structure. a) the corner of the decorated face mask, b) the opposite corner of the samples, and c) the center of the decorated mask.

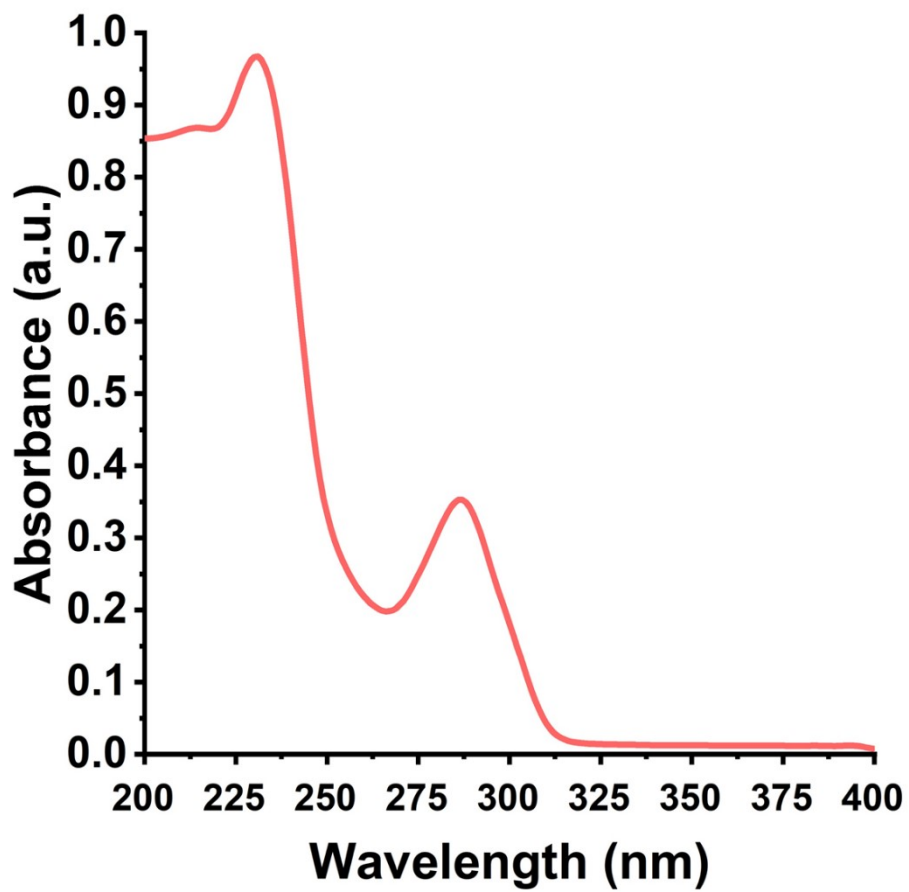




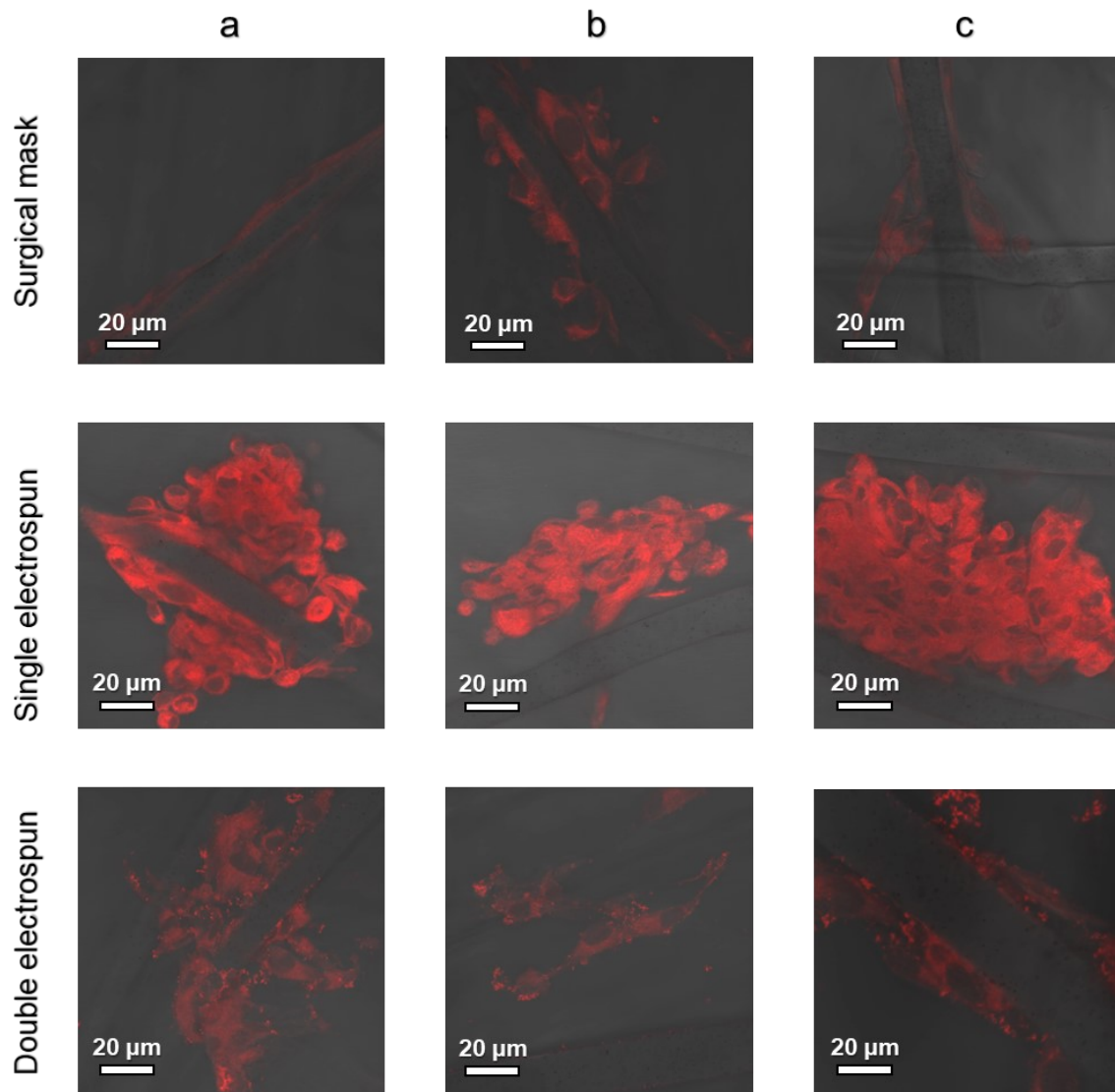
**Fig. S5** a) Temperature vs. time plot of surgical mask under different powers of laser. b) Time-temperature plots of nanostructured face mask photo-response upon NIR irradiation with different powers of laser.



**Fig. S6** a) Schematic of surgical mask irradiated by NIR laser. b) Thermographic image of non-decorated surgical face mask upon NIR irradiation to indicate maximum temperature rise of the normal mask.



**Fig. S7** UV-Vis absorption spectra of DCFH<sub>2</sub> between  $\lambda = 200$  and 400 nm



**Fig. S8** Confocal microscopy images of cells grown on tested masks. Three images represent the images taken from different spots on the same mask. Red is the cell membrane stained with FM 4-64 membrane stain.

**Table S1.** The results of bacterial filtration efficiency tests of surgical face mask.

<b>Tested sample</b>	<b>Total bacterial count (cfu)</b>	<b>Bacterial filtration efficiency (%)</b>
<b>Negative control (mean of two negative control runs)</b>	0	–
<b>Positive control (mean of two positive control runs)</b>	2947	–
<b>Mask no. 1</b>	1265	57.1
<b>Mask no. 2</b>	1201	59.2
<b>Mask no. 3</b>	1357	54.0
<b>Mask no. 4</b>	1322	55.2
<b>Mask no. 5</b>	1286	56.4
<b>Mask no. 6</b>	1364	53.7
<b>Mask no. 7</b>	1406	52.3
<b>Mask no. 8</b>	1385	53.0
<b>Mask no. 9</b>	1420	51.8
<b>Mask no. 10</b>	1187	59.7

**Table S2.** The results of bacterial filtration efficiency tests of single electrospun layer face mask.

<b>Tested sample</b>	<b>Total bacterial count (cfu)</b>	<b>Bacterial filtration efficiency (%)</b>
<b>Negative control (mean of two negative control runs)</b>	0	–
<b>Positive control (mean of two positive control runs)</b>	4869	–
<b>Mask no. 1</b>	484	90.1
<b>Mask no. 2</b>	594	87.8
<b>Mask no. 3</b>	530	89.1
<b>Mask no. 4</b>	438	91.0
<b>Mask no. 5</b>	569	88.3
<b>Mask no. 6</b>	311	93.6
<b>Mask no. 7</b>	558	88.5
<b>Mask no. 8</b>	194	96.0
<b>Mask no. 9</b>	396	91.9
<b>Mask no. 10</b>	714	85.3



**Table S3.** The results of bacterial filtration efficiency tests of double electrospun layer face mask.

<b>Tested sample</b>	<b>Total bacterial count (cfu)</b>	<b>Bacterial filtration efficiency (%)</b>
<b>Negative control (mean of two negative control runs)</b>	0	–
<b>Positive control (mean of two positive control runs)</b>	3438	–
<b>Mask no. 1</b>	389	88.7
<b>Mask no. 2</b>	290	91.6
<b>Mask no. 3</b>	28	99.2
<b>Mask no. 4</b>	244	92.9
<b>Mask no. 5</b>	124	96.4
<b>Mask no. 6</b>	293	91.5
<b>Mask no. 7</b>	322	90.6
<b>Mask no. 8</b>	230	93.3
<b>Mask no. 9</b>	488	85.8
<b>Mask no. 10</b>	269	92.2

**Table S4.** The content of gold nanorods in each electro sprayed face mask.

<b>Tested sample</b>	<b>Amount of gold nanorods (<math>\mu\text{g}</math>)</b>
<b>1:2.5</b>	1664
<b>1:5</b>	832
<b>1:10</b>	416
<b>1:20</b>	208
<b>1:50</b>	83