Supporting Information (SI):

Nanowire-Modified 3D Electrode Enabling Low-Voltage Electroporation for Water Disinfection

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Supporting Information: including experimental details, 5 pages, 3 figures, 2 tables and one part of discussion.

Supplementary Figures and Tables

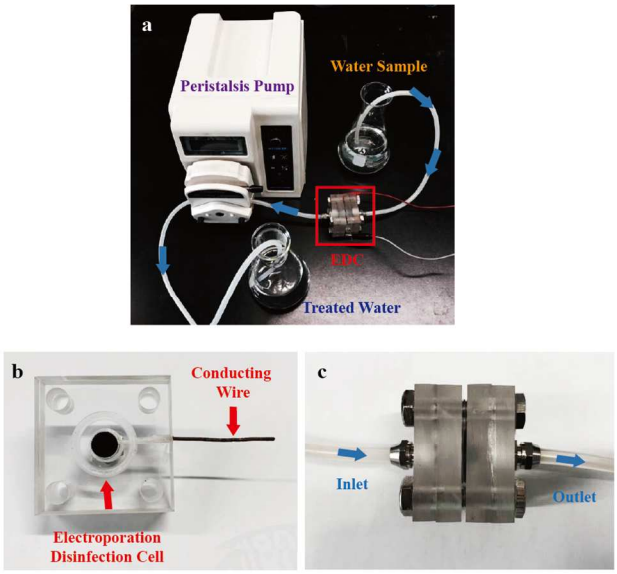

Figure. S1. Electroporation-disinfection cell (EDC). (**a**) Image of the experiment setup showing an EDC device during operation. Bacteria in water sample pumped by peristalsis pump flew through an EDC device and were inactivated by electroporation-disinfection. (**b**) Image of an opened EDC showing a copper-oxide nanowire (CuONW)-modified 3D copper foam electrode attached with a conducting wire. (**c**) Image of an EDC device showing the water flow direction during operation.

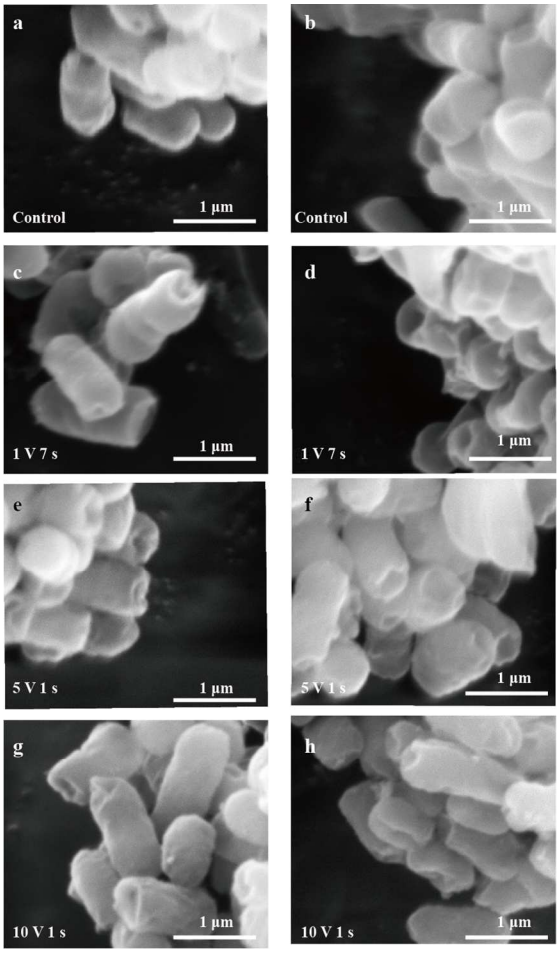

Figure. S2. Scanning electron microscopy (SEM) images of untreated (**a** and **b**) and treated (**c**-**h**) *E. coli* after 1 V, 7 s (**c** and **d**); 5 V, 1 s (**e** and **f**) and 10 V, 1 s (**g** and **h**) EDC treatment.

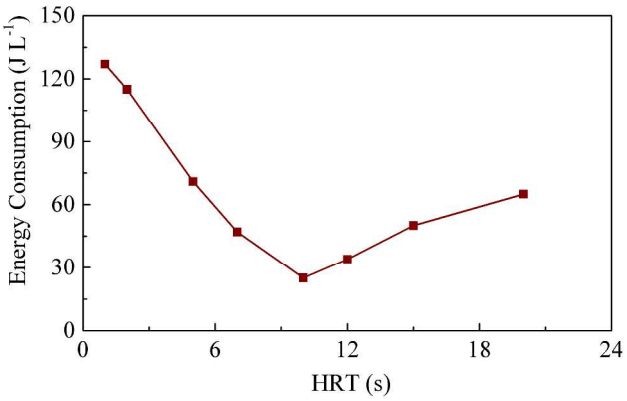

Figure. S3. Energy consumption of EDC treatment at different HRTs and corresponding lowest safe voltages which is the lowest voltage applied to EDC devices ensuring bacteria inactivation with no detectable bacteria at specific hydraulic retention time (HRT). The disinfection mechanism of electroporation guarantees an exceedingly low operation voltage (1 V) with a short contact time (7 s) and achieves a minimum energy consumption (25 J l-1) which is the most effective parameter in this study.

Table S1. Energy consuming of EDC treatment at different hydraulic retention time.

HRT (s)	Flux (mL s^{-1})	Lowest Safe Voltage[a] (V)	Current (mA)	Energy Consumption[b] (J L^{-1})
1	0.79	5	20	127
2	0.39	5	9.0	115
5	0.16	2	5.7	71
7	0.11	1	5.2	47
10	0.08	1	2.0	25
12	0.07	1	2.4	34
15	0.05	1	2.5	50
20	0.04	1	2.6	65

[a] lowest safe voltage is the lowest voltage applied to EDC devices ensuring bacteria inactivation with no detectable bacteria at specific HRT.

[b] Energy Consumption = (Lowest Safe Voltage × Current) / Flux.

Table S2. General Information of secondary effluents from two wastewater treatment plants (WWTPs).

	Name	pH	Total dissolved solids ($mg\ L^{-1}$)	Bacteria Conc. ($CFU\ mL^{-1}$)
WWTP1	Xiao Jia He WWTP	6.8	418	3200
WWTP2	Bei Xiao He WWTP	7.2	545	7900

Additional discussion on EDC disinfection mechanism

During EDC treatment, bacteria samples were dispersed in normal saline (9.0 g l^{-1} sodium chloride) to keep the fluidic pressure of substrate close to the cytoplasm. Thus, changing of fluidic pressure and ionic concentration wouldn't be the major reason for bacteria inactivation during EDC treatment.

Control samples were passed through electrodes without applying voltage. Little bacteria inactivation (Fig. 2a) indicated that sheer force and mechanical stress of nanowires were not the major reason for bacteria inactivation during EDC treatment.

During the 1 V EDC treatment, currents were minimum (<3 mA) indicating little electrochemical reaction and trace heat generation. Thus, heat generated by EDC treatment can be neglected. We also measured the temperature of both inlet and outlet, and no temperature change was found during the treatment. Thus, Joule heat wasn't major reason for bacteria inactivation during EDC treatment.

Finally, we measured the pH of each water sample (both inlet and outlet). The pH of water samples were all around 7.0, indicating that pH change wasn't the major reason for bacteria inactivation during EDC treatment.