Low-Voltage Nanowire-Assisted Electroporation for Water Disinfection (#8099)

For continuous antimicrobial use in municipal pipeline systems

Researchers at Georgia Tech have developed a device for chemical-free water disinfection in municipal pipelines. The coaxial-electrode electroporation disinfection cell (CEEDC) technology deactivates pathogens by exposing them to a high-strength electrical field and damaging the cell membrane. The technique is an alternative to conventional chlorine disinfection, which is associated with the generation of carcinogenic byproducts.

The CEEDC device consists of a cylindrical reactor chamber, two electrodes, a tubular outer electrode, and a coaxial center electrode with nanowires perpendicular to the surface. The nanowires enhance the local electric field by several orders of magnitude, enabling system operation with very low voltage (1-2 V) that is generated *in situ* by flowing water. The design enables a two-level electric field enhancement and directional cell transportation, both of which assist disinfection. This point-of-use disinfection technology minimizes the use of chemicals, requires little maintenance, and can be easily incorporated into existing water distribution systems.

Benefits/Advantages

- **Efficient**: Achieves rapid and universal pathogen inactivation with low power consumption
- **Flexible**: Features a configurable structure that can be placed easily into existing pipeline systems
- **Chemical-free**: Permits disinfection without the addition of chemicals that generate harmful and carcinogenic byproducts

Potential Commercial Applications

This technology is for water disinfection in a wide range of pipeline systems:

- Municipal
- Swimming pools and water parks
- Hospitals
- Beverage companies
- Aquariums

Background/Context for This Invention

Chlorine disinfection has been protecting people from lethal pathogenic diseases for more than 100 years.

Though chlorination is a low-cost and easily applied solution, the formation of disinfection byproducts poses carcinogenic health threats. Other disinfection methods exist—ultraviolet radiation, membrane filtration, and ozonation—yet require high energy inputs and are unreliable. Low-voltage electroporation techniques have emerged as a promising water disinfection technique. Used in the medical field to deliver DNA and/or proteins into cells, electroporation works by increasing the permeability of the cell membrane. Georgia Tech researchers have adapted the technique to enable pathogen deactivation in water pipeline systems.

Jianfeng Zhou
Ph.D. Student - Georgia Tech School of Civil and Environmental Engineering

Dr. Xing Xie
Assistant Professor - Georgia Tech School of Civil and Environmental Engineering

More Information

U.S. Application Filed - 16/782,430

Publications

Locally Enhanced Electric Field Treatment (LEEFT) With Nanowire-Modified Electrodes for Water Disinfection In Pipes, Environmental Science: Nano, November 2019

Water pipe technology kills microorganisms with localized electric field

---

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/low-voltage-nanowire-assisted-electroporation-water-disinfection

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot