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UV-C Wavelength Radially Emitting Particle-Enabled Optical Fibers for Microbial Disinfection

Background

Although chlorine remains one of the most widely used water disinfectants throughout the world, the toxicity of the chemical itself and of its by-products poses significant health risks. Non-chemical disinfectants such as ultraviolet (UV) irradiation has been an attractive alternative and is gaining acceptance in both large-scale and small-scale systems. Specifically, UV light in the germicidal wavelength range of 250nm to 280 nm (in the UV-C band) is effective in destroying microbial DNA structure, preventing reproduction of pathogens (e.g., Giardia, Legionella) and bacteria or biofilm growth in water, air, or surfaces. Light Emitting Diodes (LEDs) can provide UV-C light to disinfect water. Unfortunately, LEDs have very small area to emit light, thus necessitating numerous LED units to cover a treatment reactor. Furthermore, LEDs require wiring and cannot be put into all reactor shapes or geometries. Therefore, a solution that can dose UV-C light effectively by LEDs and uniformly within the reaction vessel can accelerate adoption of UV-based water disinfection technologies or use in new locations to control biofilm growth.

Invention Description

Researchers at Arizona State University have developed a new method for effective delivery of LED UV-C light for water disinfection. This is accomplished by distributing light through flexible optical fibers that provide the bendability to reach areas of otherwise inadequate light exposure by using LEDs alone. Launching light from LEDs into optical fibers increases light emission area by over 500x. Of particular novelty is the integration of particle beads (e.g., silica spheres) within the fiber walls underneath a UV-C-transparent polymer coating. As light passes through the fiber longitudinally, these beads serve to also scatter light radially into vessel. Fiber properties, including light-scattering parameters, can be easily adjusted in the fabrication process and is a demonstrated scalable process.

Potential Applications

- Fluid disinfection
- Water or air treatment
- Biofilm mitigation

Benefits and Advantages

- Innovative – Uniquely combines advancements in optical fibers and UV-LED light sources
- Practical – Flexible optical fibers can deliver light to previously unreachable areas
- Adaptable – Optical properties can be tuned according to wavelengths used
- Versatile – Compact and energy-efficient design suits both small-scale and large-scale applications
- Cost Effective – More efficient use of LED light means fewer LEDs are needed for an application

Homepage of Professor Paul Westerhoff