Considerations regarding airborne pathogen deactivation in a CEF device at atmospheric pressure

Technical brief

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Methods often used for air sterilization (disinfection) are UV irradiation and DBD discharge.

One of the biggest drawbacks of UV irradiation is that it requires a direct "line of sight" exposure to be effective; "shadowing" may occur when used to treat airborne bacteria, a process whereby the upper layers of a bacterial cluster are exposed and deactivated but are providing a protective shield for the lower layers.

Drawbacks of DBD discharge are:

(i) pathogens are not exposed directly to the complex energy fields as it is a dielectric (often glass) between the electrodes.

(ii) a significant part of the energy is transformed in heat, requiring cooling of the device.

The innovative device presented here is using complex energy fields (CEF). The CEF device, (Fig.1) may be placed in a double-helix like coil, or similar device which can generate customized magnetic fields (for clarity not represented in this brief). It also may have multiple needles and/or power sources that may be synchronized.

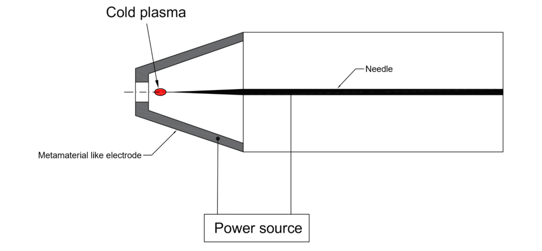

FIG. 1

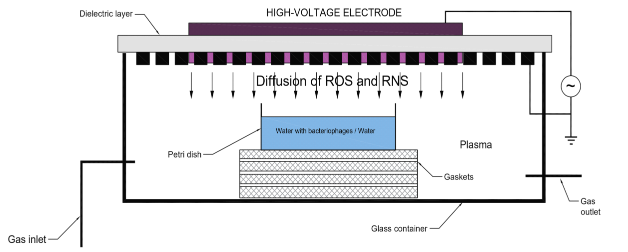

FIG. 2

In the CEF device, pathogens are exposed directly to the complex energy fields as opposed to reactive species generated by the discharge in the dielectric barrier discharge (DBD) devices (Fig.2). Also, the device is portable, operating at room temperature, atmospheric pressure, doesn't use noble gases and doesn't need cooling. In certain conditions, interaction(s) between complex energy fields, waves and/or scalar entities can create concentration of energy at points on, or near a metamaterial like electrode (Fig.3), or on the molecules (pathogen itself), in which, the energy levels and/or field(s) intensity can exceed molecules bond strength, causing breaking the bonds of C=C, C-C, O-H, etc. The shape and size of the electrode may vary depending on the application in which is used.

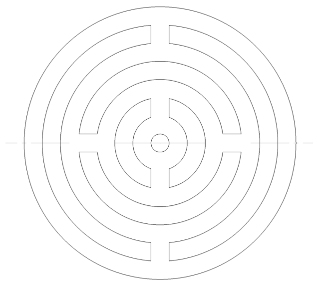

FIG. 3

The charge distribution over a molecule and magnetic fields in a specific point/surface of a molecule can be determined with specialised software. These calculated values enable the design of customised electrodes, changes in device architecture in order to induce maximum damages to a molecule(s) bond(s).

These conditions may induce severe damage to the chemical and biological structure of airborne pathogens, Fig.4.

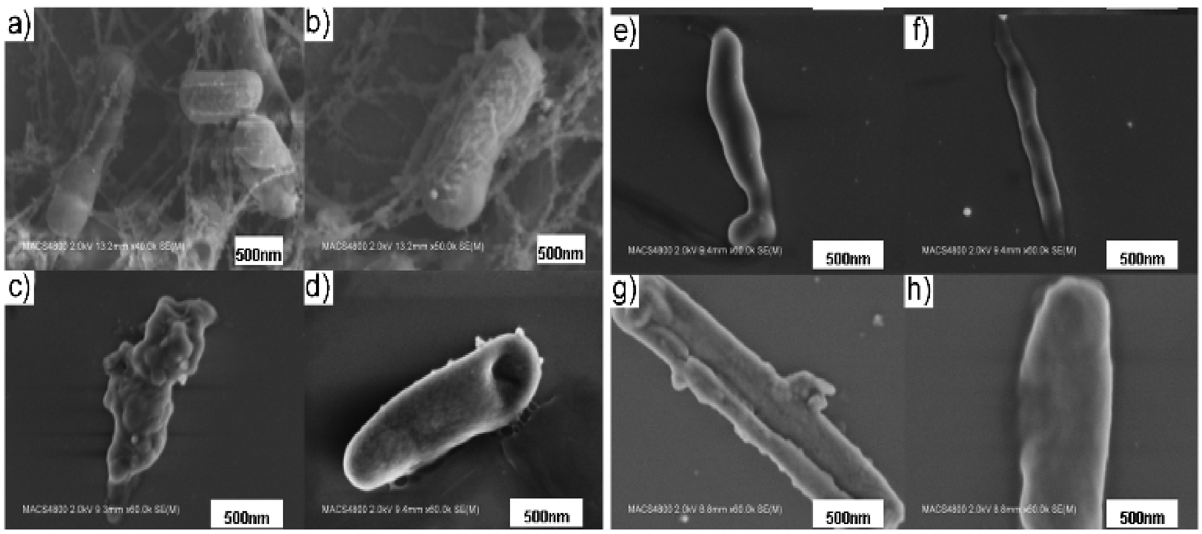

FIG.4

NASA Ames Research Center. SEM image of:
(a) and (b) - untreated E. coli
(c) to (h) - E. coli captured from air and passed through the DBD device.
E. coli was chosen as a model organism for this study because of its prevalence in many human occupied spaces, and its rod-like structure makes it easier to see morphological surface changes.

Cold atmospheric plasma (CAP) created within the CEF device exhibits variable interaction(s) with electromagnetic and/or other fields, and/or other scalar or vectorial entities, waves, and/or with the structure of pathogens. These interactions can cause bacterial membrane changes, and bacterial inactivation, amplifying the damages already induced to bacterial membranes by reactive oxygen and nitrogen species generated by CAP or in another way.

The mechanism of damage induced by CAP to viruses in the CEF device has to be further investigated as the interactions are complex and not well understood.

During device operation, a fine structured black deposition on metamaterial like electrode has been observed. Further investigation is required to determine the nature of this deposition resulting from the decomposition of materials entering the device. The device can be used also to sequestrate particulate matter but this topic is not addressed in this brief.

Conclusions:

The CEF device:

a. represents a method to effectively deactivate airborne bacteria.

b. may have a nonspecific bactericidal effect, eliminating the risk of developing bacterial resistance. It may kill multiresistant bacterial strains, typically found in healthcare facilities, office buildings, etc.

c. combines in a single device the effects of direct exposure of airborne bacteria to CEF, airborne bacteria interaction with CAP, with simultaneous exposure to oxygen and nitrogen reactive species and other species generated in the device.

In a particular facility, the environment can contain spores, molds and other Gram-positive bacteria in addition to E. Coli. Further studies on the inactivation of other types of pathogenic bacteria or viruses are required.

References:

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