Dense Medium Plasma: A Promising New Water Treatment Approach

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Abstract. Ensuring water quality that conforms to regulated standards is a challenging problem with multiple dimensions, including cost, efficiency, and safety. For example, chemical techniques used for conventional drinking water treatment are usually effective, but often produce toxic by-products, such as trihalomethanes (THMs). This study describes the development of plasma technology as an alternative water treatment approach and in particular focuses on the challenges associated with the formation of plasmas in a dense medium such as water. Plasma treatment is highly attractive because the multiple reactive species produced ($O^{\bullet}$, $OH^{\bullet}$, O_3, e^-, O_2^-, O^-, O_2^+ etc.) are combined with UV light to work synergistically in the destruction of harmful microbes and other organic contaminants. Experiments with the RF-powered atmospheric pressure plasma in air have demonstrated a five log removal of *Escherichia coli* after just a few seconds of exposure, without significant heat generation. The fact that reactive species are generated without the addition of any harmful reagents and recombine immediately after turning off the device is a central feature of the approach. Recent experiments have focused on adapting the plasma for water treatment and have also demonstrated significant *E. coli* removal. The dense medium plasma is thus a promising method of treating water without the addition of chemicals, and may prove to be effective for the removal of other harmful microorganisms such *Cryptosporidium*, *Salmonella*, and *Bacillus* spores, as has been observed at atmospheric pressure. This study will describe the development of the RF-powered dense medium plasma for water treatment and the initial suite of results.

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