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Cold Atmospheric Plasma: An Inside Look Through Optical Diagnostics for Biomedical Applications

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Abstract

An emerging technology for medical applications is cold atmospheric plasma (CAP). CAP is generated using various gasses in a “pen” to create room temperature plasma and then carry the effluents and species. Success has been shown when cold atmospheric plasma is applied to oncology treatments, accelerated wound healing, pathogen disinfection, and various material-changing effects. However, the mechanisms behind these effects are still speculative. This study uses multiple diagnostic techniques including fast photography, two wavelength emission spectroscopy and optical emission spectroscopy to characterize the plasma properties and eventually further test the plasma’s interaction with biological samples. The plume dynamics are observed using fast photography methods, allowing determining visible intensity, plume length, and peak intensity, as gas flow rates and mixture are varied. A two wavelength emission spectroscopy approach is used for determination of plume temperature, using narrow band optical filters at 480 nm and 510 nm. Pixel-by-pixel, ratio of intensities is used to predict the temperature with novel image processing code. Optical emission spectroscopy is used to determine the chemical species along the plume length. The temperature of the plume is found to be slightly above room temperature at the core and then cools towards the tip. The temperature varies with intensity and peaks around 6.5lpm with pure argon and varies with gas mixture. Pure argon has the greatest intensity and plume length. The plume seems to be mostly comprised of reactive oxygen and nitrogen agents (RONS). It is likely these RONS that cause the various effects, especially in oncology.

Keywords

Cold Atmospheric Plasma, Optical Diagnostics, Plasma, Oncology, Spectroscopy, Argon