Chapter 10
Plasma in Medicine and Agriculture

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ABSTRACT

This chapter provides a comprehensive exploration of the emerging applications of plasma in medicine and agriculture. Plasma, the fourth state of matter, offers unique properties that make it a versatile tool with transformative potential in these domains. The chapter delves into the advancements in plasma technology, discussing improved control over plasma parameters and the development of precise plasma sources. In the medical field, plasma has shown promise in wound healing, cancer treatment, sterilization, and drug delivery. Its non-invasive nature, antimicrobial properties, and ability to selectively target specific tissues make it an attractive option for tissue regeneration, infection control, and personalized therapy. The chapter emphasizes the potential benefits of plasma in enhancing patient outcomes and reducing healthcare costs. In agriculture, plasma-based technologies offer sustainable solutions for seed treatment, plant disease control, and crop improvement. Plasma treatments have proven effective in reducing microbial contamination, improving seed germination, stimulating plant growth, and enhancing crop resilience against diseases and environmental stresses. The chapter underscores the potential contributions of plasma-based technologies to increased agricultural productivity, reduced pesticide usage, and enhanced food security. The chapter further explores the emerging applications of cold atmospheric plasma (CAP), which operates at near-ambient temperatures. CAP has shown promise in wound healing, cancer therapy, plant disease control, and crop improvement. The underlying mechanisms of CAP's effects and its versatility in addressing diverse challenges in medicine and agriculture are discussed. Additionally, the chapter investigates the interactions between plasma and nanoparticles, highlighting their potential in targeted drug delivery, wound healing, and plant disease control. The ability to activate or modify nanoparticles using plasma opens new avenues for enhanced therapeutic and agricultural interventions.

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1. INTRODUCTION TO PLASMA TECHNOLOGY

1.1 Definition of Plasma

Plasma, often referred to as the fourth state of matter, is a highly ionized gas consisting of positively and negatively charged particles that are in a quasi-neutral state overall. It is characterized by its ability to conduct electricity and exhibit unique physical and chemical properties. In the context of medicine and agriculture, plasma technology refers to the utilization of plasma for various applications in these fields (Ivanova et al., 2018).

1.2 Plasma States and Properties

Plasma exists in a wide range of states, from low-temperature plasmas (LTPs) to high-temperature plasmas (HTPs), each with distinct characteristics. LTPs, also known as non-equilibrium plasmas, are of particular interest in medical and agricultural applications due to their ability to operate at room temperature while maintaining their biological activity (Fridman et al., 2008). These plasmas typically contain a variety of reactive species, such as ions, electrons, radicals, and excited molecules, which play a crucial role in their biological effects (Guerrero-Preston et al., 2016).

1.3 Plasma Generation Techniques

Several methods are employed to generate plasma, including direct current (DC) discharges, radiofrequency (RF) discharges, microwave discharges, and atmospheric pressure plasma jets. Each technique has its advantages and limitations depending on the desired application. For example, atmospheric pressure plasma jets have gained popularity due to their portability, ease of use, and ability to treat large surface areas (Shahidi et al., 2020). Moreover, advancements in plasma technology have led to the development of cold atmospheric plasmas (CAPs), which operate at near-ambient temperatures and exhibit unique characteristics suitable for biomedical and agricultural applications (Graves et al., 2014).

1.4 Importance of Plasma in Medicine and Agriculture

Plasma technology has emerged as a promising tool in the fields of medicine and agriculture, offering numerous applications and benefits. In medicine, plasma-based techniques have shown great potential in sterilization processes, wound healing, tissue regeneration, and even cancer therapy (Kong et al., 2019). Similarly, in agriculture, plasma has demonstrated efficacy in seed germination, pest control, soil decontamination, and waste management, contributing to sustainable farming practices (Misra et al., 2020). The unique characteristics of plasma, such as its ability to generate reactive species and modify surface properties, make it a versatile tool for various applications in these fields.