NUMERICAL SIMULATION-BASED OPTIMISATION OF PLASMA SOURCES FOR MEDICAL APPLICATIONS

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Abstract. Plasma technology has potential to generate significant societal benefits through a range of biomedical applications. In terms of widespread use in real-word scenarios, plasma applications span the entire spectrum from early stage proof-of-concept (e.g. cancer therapy) to emerging clinical tools (e.g. chronic wound treatment) to proven, indispensable clinical interventions (e.g. electrosurgery). A common thread in all biomedical applications is the interaction between a complex plasma system, typically containing a range of biologically active components such as photons, reactive species, electric fields and currents, and a complex biological system. In such systems, optimization of application outcomes requires optimization of the plasma properties that drive the relevant biological effects. Given the wide variety of active components that may play a role, and the experimental difficulties in measuring these components, optimization through experiment alone is a significant challenge. A promising approach to overcome this challenge is the use of experimentally validated numerical simulation approaches for plasma and device optimization. Here, various simulation approaches are used to demonstrate the potential for simulation-based optimization of plasma sources for cancer therapy and disinfection of surfaces. In the context of cancer therapy, a combined approach utilizing experimentally validated plasma-chemical kinetics modelling (Schröter *et al.* 2018, Wijaikhum *et al.* 2017) and computational fluid dynamics is used to determine design parameters for the scaling of reactive oxygen species delivery via needle-like plasma sources at atmospheric pressure for prostate cancer therapy. In the context of plasma disinfection, 2D hybrid plasma simulations (Tian and Kushner 2015) are used to predict photon fluxes incident on different surfaces of an object placed inside a low-pressure plasma reactor to assess the optimum plasma operating conditions for the disinfection of complex structures.

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