REACTIVE PLASMA MICROJET AND WATER SYSTEM: GENERATION, CONVERSION, AND CONTRIBUTIONS TO BACKTERIA INACTIVATION – AN ANALYSIS BY ELECTRON SPIN RESONANCE SPECTROSCOPY

Ruonan Ma, Ruixue Wang, Jue Zhang, Jing Fang
Academy for Advanced Interdisciplinary Studies, Peking University, Beijing, China, 100871

Haiyan Wu, Peng Sun, Hongqing Feng, Yongdong Liang
College of Engineering, Peking University, Beijing, China, 100871

Haixia Zhou
West China College of Stomatology, Sichuan University, Chengdu, China, 610000

Jingfen Lu
National Research Laboratories of Natural and Biomimetic Drugs, Beijing Medical University, Beijing, China, 100871

Weidong Zhu
Department of Applied Science and Technology and Center for Microplasma Science and Technology, Saint Peter’s College, New Jersey, USA, 07306

Electron spin resonance (ESR) spectrometry is the most direct and sensitive method for detecting certain reactive oxygen species (ROS)\(^1\). By ESR diagnosis, plasma–water reactions can be elucidated, which is meaningful for guiding its clinical application.

This study manages to broaden the scope and depth of ESR analysis on non-thermal plasma. It presents a detailed ESR study of three types of ROS, namely hydroxyl radical (\(\cdot\)OH), superoxide anion radical (\(\cdot\)O\(_2\))\(^-\)), and singlet oxygen (\(\text{^1O}_2\)), generated in a direct current He/O\(_2\) (2\%) non-thermal plasma microjet-water system. ESR spin trapping with the assistance of radical scavengers directly or indirectly confirms the existence of these ROS. \(\text{^1O}_2\) is shown to be the precursor of \(\cdot\)OH. The concentrations of \(\text{^1O}_2\) and \(\cdot\)OH are evaluated by comparing the ESR signals from plasma microjet (PMJ) treated samples with that from different concentrations of a commercial 2, 2, 6, 6-tetramethylpiperidine 1-oxyl (TEMPO) in water under identical experimental conditions. Through the addition of SOD, D-Man and L-His as scavengers in Saccharomyces cerevisiae (S. cerevisiae) inactivation experiments, which indicated that \(\text{^1O}_2\) contributes the most to the inactivation.


* Work supported by Bioelectrics Inc. (U.S.A.), the Peking University Biomed-X Foundation and China International Science and Technology Cooperation (under Grant # 2009DF B30370: “Cold Plasma induced biological effect and its clinical application studies”)