PlasTHER THERAPEUTICAL APPLICATIONS OF COLD PLASMAS

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Photolysis effect of UV radiation on reactive species in plasma-activated water

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Introduction:

Plasma and plasma-activated liquids are used in various medical applications like implants, cleaning, and combating infections. The decontamination efficacy of plasma depends on both short- and long-lived reactive species. Active species like NO_2^-, NO_3^-, O_3, and H_2O_2 have antibacterial effects. Combining plasma-activated water with UV radiation produces highly active short-lived species like OH and ONOOH. In our previous work, the effect of this synergic modality on bacteria had been investigated[1]. Here we focus on chemical interaction of transient spark PAW with UV A radiation.

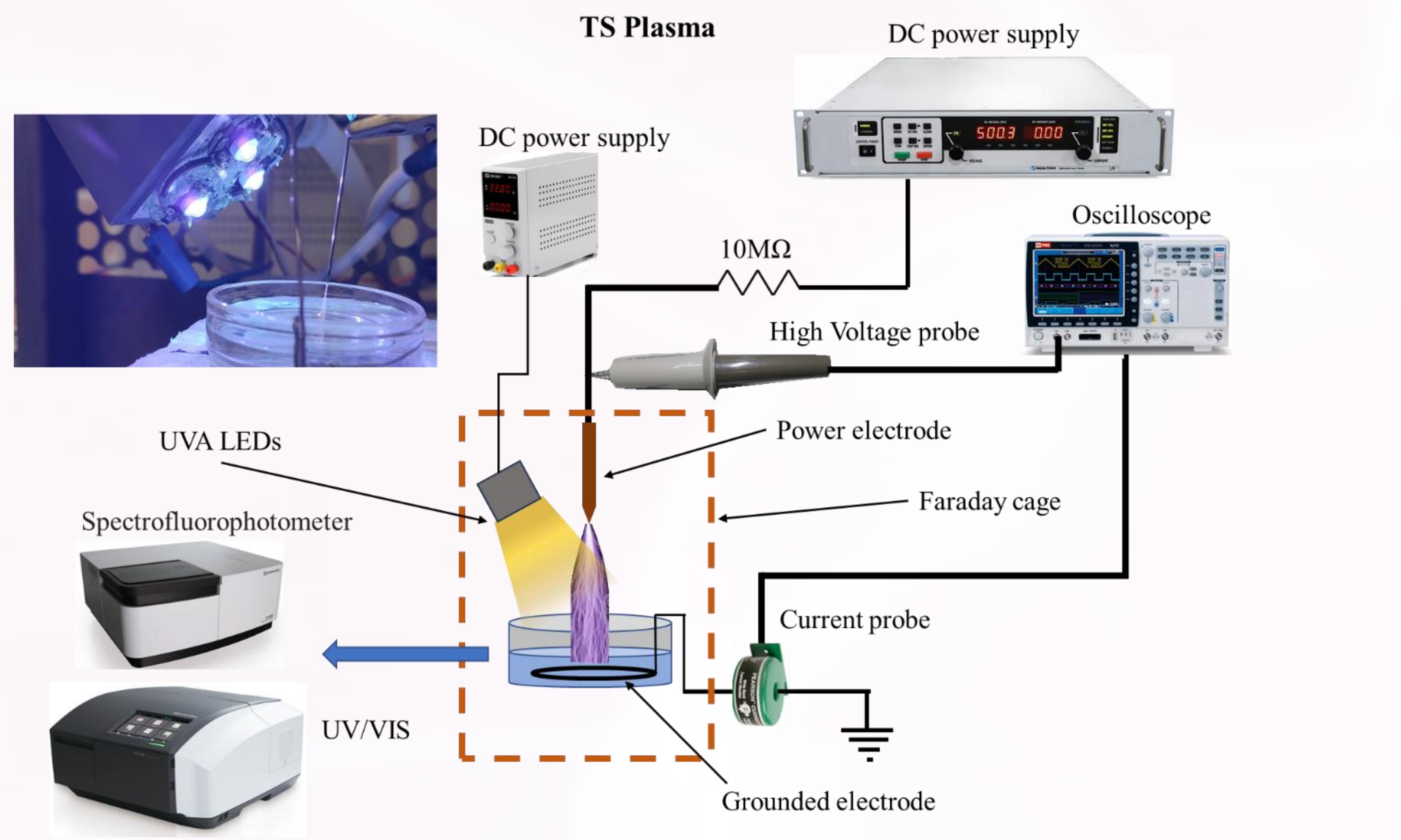

Figure 1. Schematic diagram of the transient spark plasma-UV (A or C) set-up

Result:

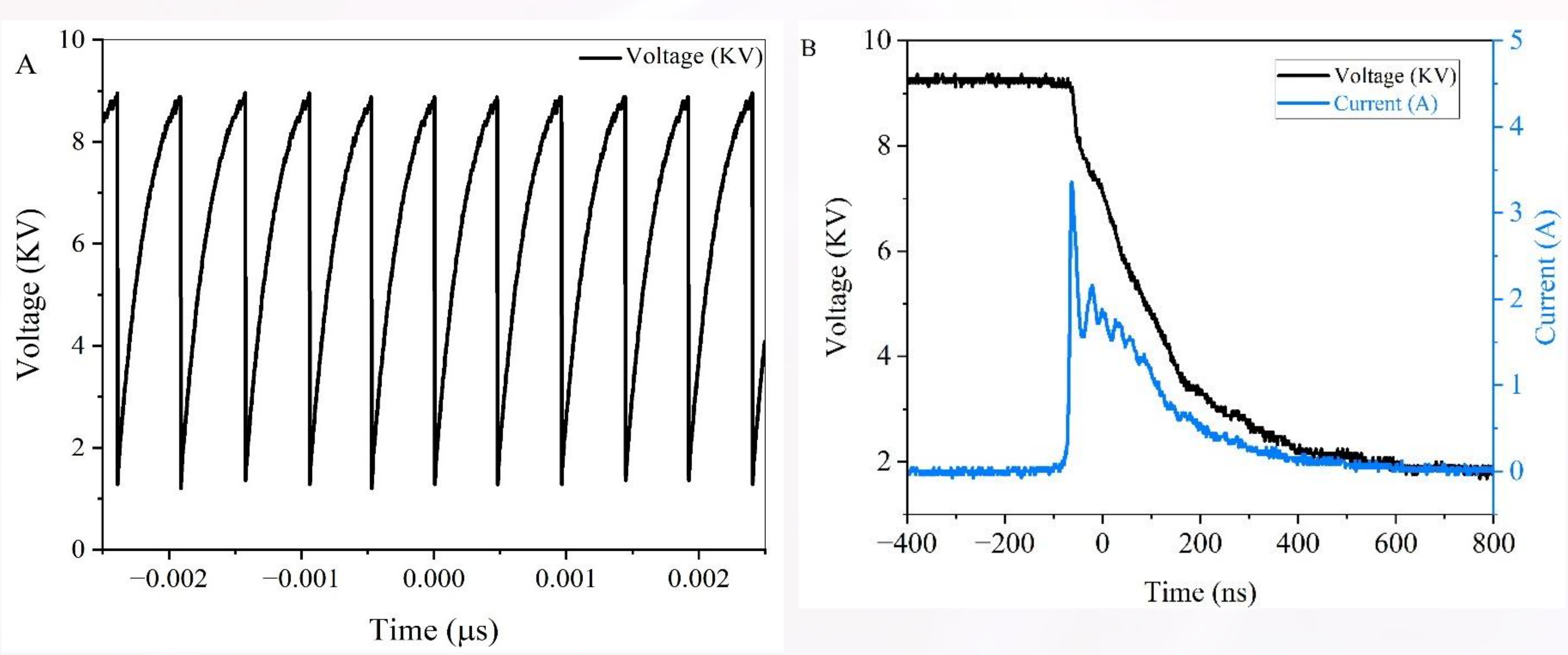

Figure 2. Voltage (A), and current-voltage waveform (B) of transient spark plasma

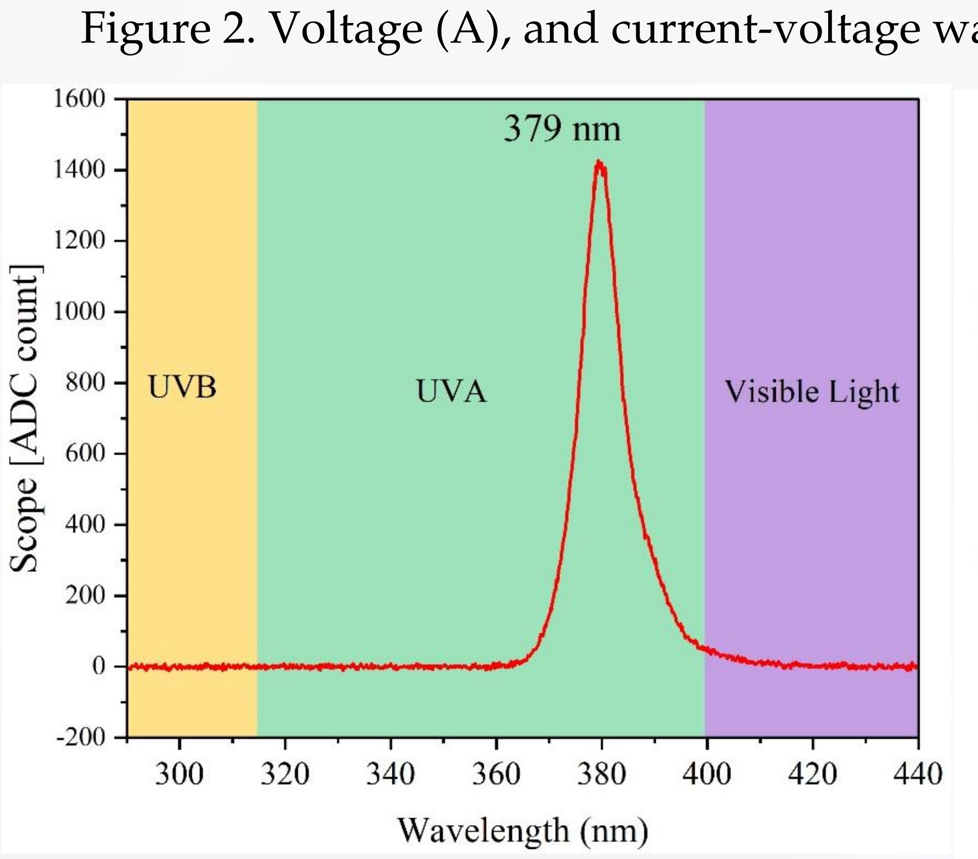

Figure 3. Wavelength of three mounted UVA-LEDs.

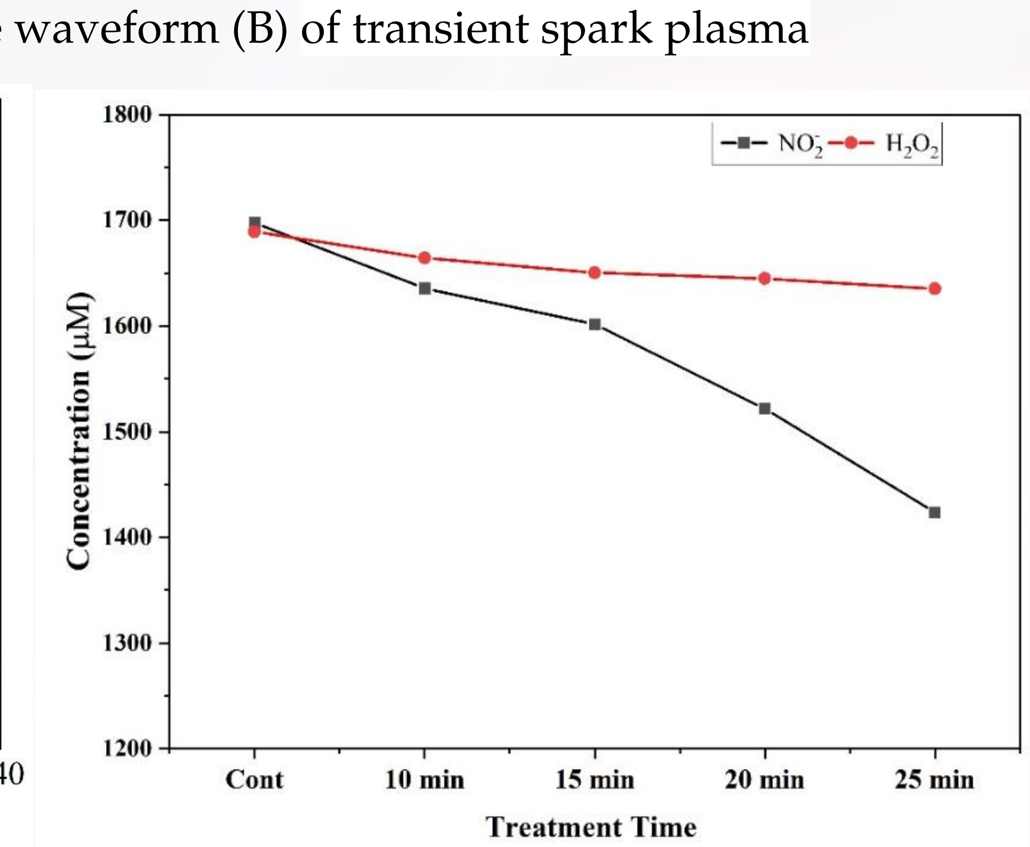

Figure 4. Concentrations of NO_2^- in pure NO_2^- solution and H_2O_2 in pure H_2O_2 solution after UVA irradiation.

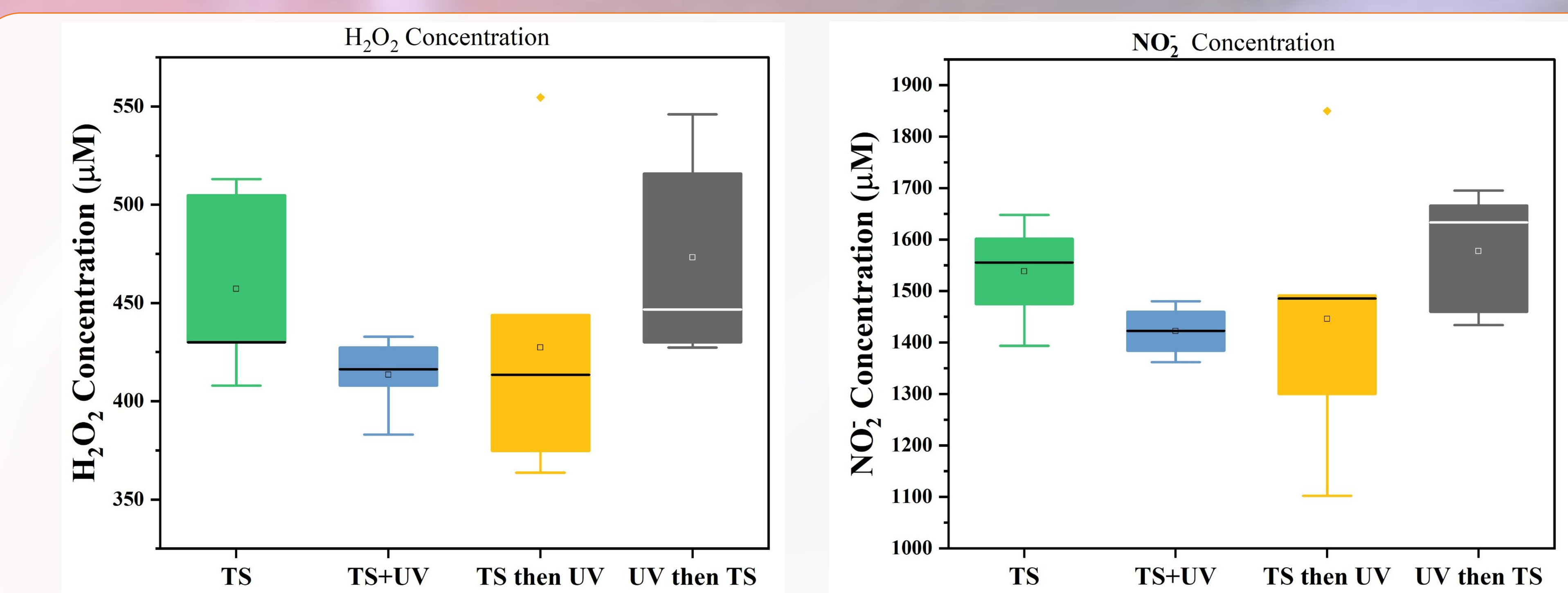

Figure 5. Concentration of H_2O_2, NO_2^- and average power with different combining treatment treatments. The power was ~4-6 W

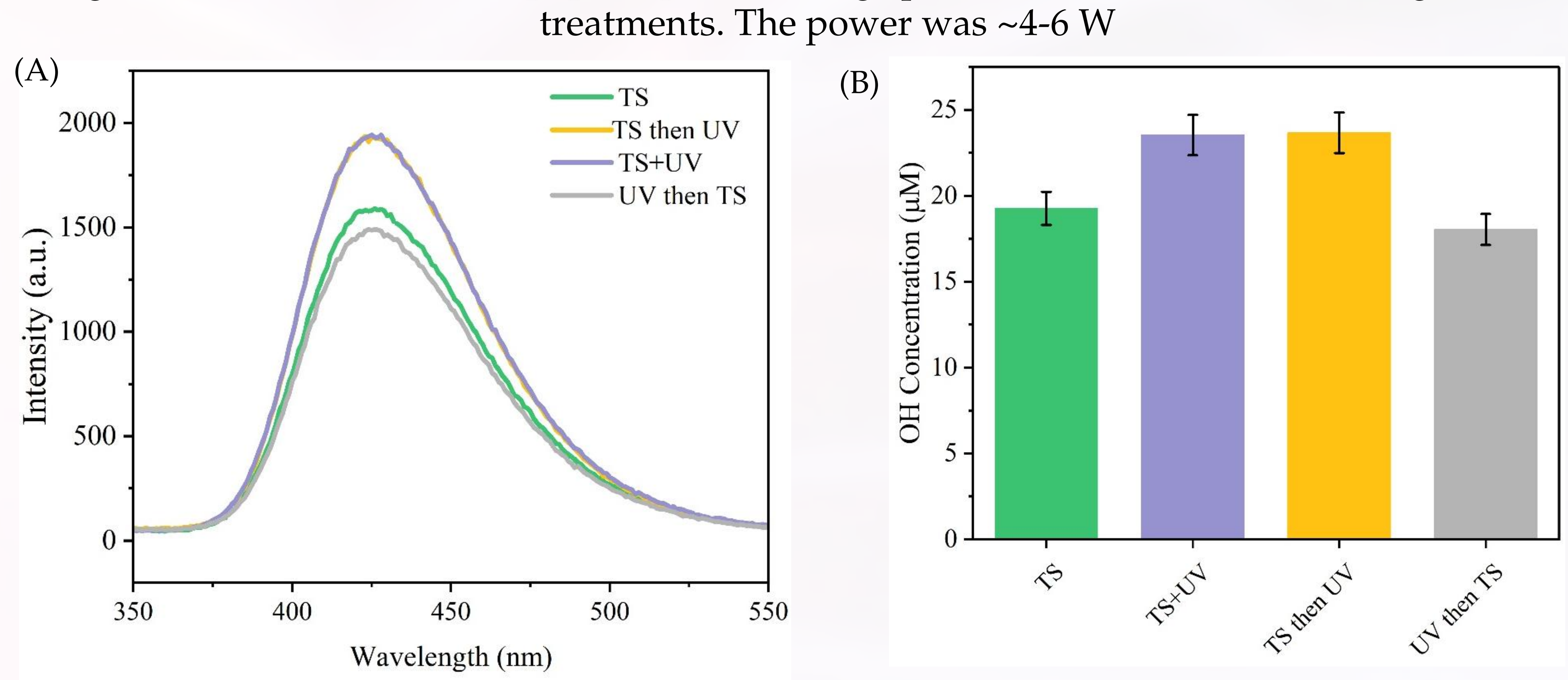

Figure 6. (A) Fluorescence spectra of aqueous TA solutions exposed to the TS, TS+UV, TS then UV and UV then TS. (B) Formation of OH radicals in aqueous TA solution for different treating group.

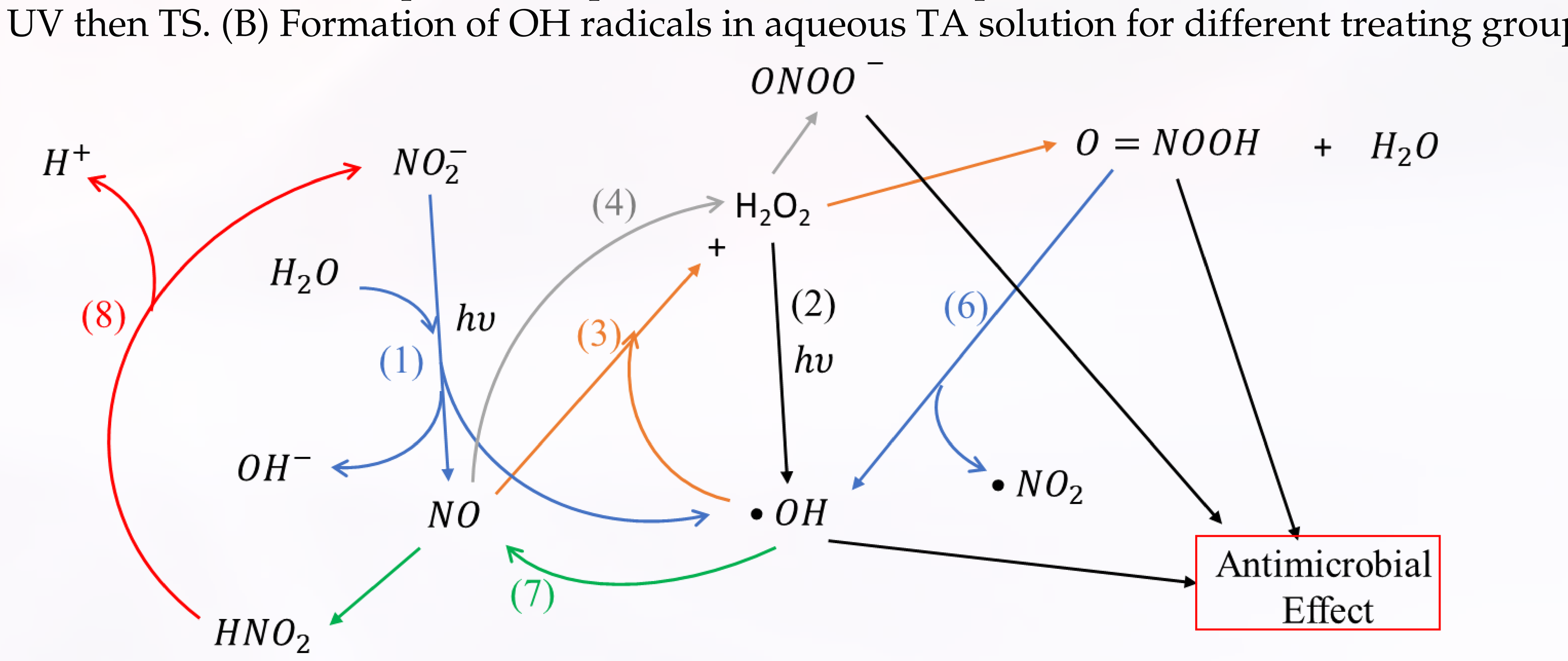

Figure 7. Overview of the chemical pathways involved in the antibacterial interaction between UVA radiation and PAW.

Conclusion:

The study reveals that external UV radiation significantly improves the functionality of plasma activated water (PAW), particularly through the photochemical production of OH radical. UV radiation can decrease H_2O_2 levels through photolysis, leading to the enhanced generation of OH and $ONOOH/ONOO^-$. PAW's high reactivity and oxidizing capacity can be thus enhanced by additional UV irradiation that supports OH production to make it more efficient in various fields, including disinfecting biological materials and inactivating bacteria [2].

Acknowledgment: Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V03-00033 EnvAdwice, and Slovak Research and Development Agency APVV-22-0247.

1-R. Mehrabifard, B. Gitura Kimani, and Z. Machala, Sep. 2024, doi: 10.2139/SSRN.4961388.

2-H. Lee, S. Park, J. Y. Park, J. Kim, and W. Choe, SSRN Electron. J., 2022, doi: 10.2139/ssrn.4240411.

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