In-situ aqueous PAA synthesis through plasma technology

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Abstract: In this contribution, we report the activation of TAED for PAA sterilant synthesis in solution via plasma jet topology, and in-situ process monitoring with FTIR-ATR.

1. Introduction

Recent studies have shown that plasma technology has been widely used in a variety of applications, including waste gas and sewage water remediation, water purification, and nitrogen fixation and ozone generation for water purification. Moreover, this technology is effective at inactivating pathogens on the surface of medical and dental devices, as well as agricultural products. In the biomedical field, cold atmospheric plasma (CAP), has gained attention due to its energetic properties and low gas temperature.[**1**] At room temperature, plasma generates a variety of reactive oxygen and nitrogen species (RONS) such as stable and transient nitrogen oxy acids hydrogen peroxide (H_2O_2), electrons, ions & UV photons, making it ideal for biomedical, disinfection and environmental applications. As part of our study, we propose an alternative disinfection method to synthesize strong sterilant PAA (peracetic acid) by activation of TAED (tetraacetylethylenediamine) in aqueous solution. [**2**]

2. Methodology

A variety of PAA precursors, gas mixtures, reactions stoichiometry, temperature variation and plasma power were studied. In this study, we use plasma jet topology for in-situ monitoring of reactive species in liquid mixture plasma using infrared spectrometry. The reactor geometry comprises a temperature-controlled borosilicate vessel with plasma jet technology.

3. Experimental setup

Fig. 1.1 presents the experimental setup composed of four main parts: plasma jet, power source, diagnostic tools and gas supply.

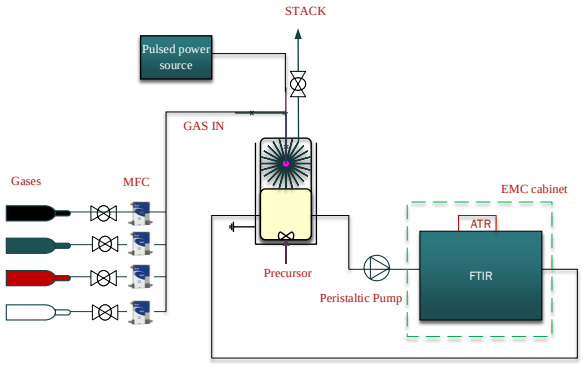

Fig 1.1. Schematic diagram of the experimental setup.

4. Diagnostic

Fourier-transform infrared spectrometry (FTIR) is a robust technique for uniquely identifying molecular structure in the mid-infrared. Due to the fact that water strongly absorbs in this region of the electromagnetic spectrum transmission spectroscopy is not possible Therefore, we measurements performed in the ATR reflection mode using a continuous flow cell. Bruker opus quant statistical analysis package for quantification PAA densities.

References

[1] J. Luo et al., Appl. Sci., **14**, 1, (2024).
[2] B. Ghimire et al., Plasma Med., **11**, 73-84 (2021).