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Degradation of perfluorooctanoic acid by gas-liquid discharge plasma

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Abstract:
Perfluorooctanoic acid (PFOA) is an artificially synthesized per-fluorinated chemical widely used in industry. It is often released into the environment without treatment and causes pollution in groundwater. In this talk, we employed a strip fountain dielectric barrier discharge (SF-DBD) plasma source to degrade PFOA from the water. The effects of power supply mode, discharge gases, pH, the conductivity of the solution, concentration, etc., on the degradation efficiency were studied. For a 250 mL sample of 75 mg/L PFOA, a 99 % degradation efficiency with a 204.5 μg/kJ energy production rate was achieved using an average power of 43 W negative pulse argon plasma for 50 min at atmospheric pressure. The total organic carbon concentration (TOC) decreased by 63 % after a 60-minute treatment. This design allows the gas-liquid interaction happened in a large volume at atmospheric pressure, so it is a promising method to efficiently remove the PFOA from water.
Better understanding the reaction mechanism is key to further improve the efficiency of the system. Therefore, the optical emission spectroscope (OES) and the radical scavenger experiments indicate that the excited argon atoms and hydroxyl radicals play a major role in PFOA degradation, while and the contributions from solvated electrons (e^{-aq}), superoxide anion radical ($\cdot O_2^-$), and singlet oxygen ($^1O_2$) are negligible in initiating cleavage reaction.

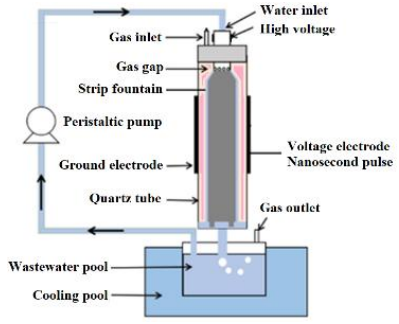

Figure 1 Schematic diagram of the SF-DBD system used in PFOA-polluted water treatment

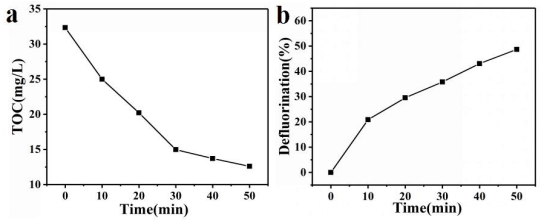

Figure 2. Variation of (a) TOC concentration and (b) the defluorination versus SFDBD plasma treatment time. Experimental conditions: negative pulse power; peak voltage: 15 kV; power frequency: 6 kHz; pulse width:500 ns; power: 43 W.

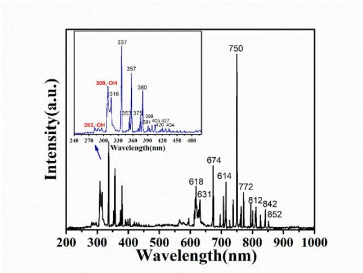

Figure 3 The optical emission spectrum in Ar discharge in the range of 240～900 nm (the inset is magnified in 240～500 nm) (Experimental conditions: the power supply: negative pulse peak voltage: 15kV; power frequency:6 kHz; pulse width:500ns; average power: 43 W).

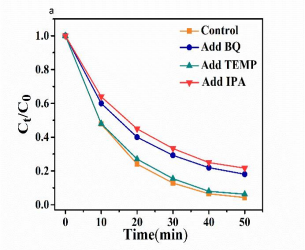

Figure 4 Effect of radical scavengers on PFOA degradation

References
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Note: Abstract should be in (full) double-columned one page.