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NO_x Production in a Stagnant Liquid Layer Using Combined Submerged Plasma Micro-Jets: Synergistic Effects of Jet Dynamics and Catalysts

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We report a comprehensive study of plasma–liquid interfacial dynamics in a non-equilibrium, atmospheric-pressure micro plasma reactor based on NO_x production. The advantages of co-feeding N_2 and O_2 in a single plume are demonstrated by the dual-jet configuration, which produces 2.5 times more NO_x than a single jet under optimization at 30–50% of N_2 in the N_2/O_2 feed, as demonstrated by the correlation of systematic experiments with qualitative flow dynamics analysis. Jets inclined between 30 and 45 degrees create logical vortical structures that penetrate the silent boundary layer and increase interfacial mass transfer; these effects are amplified when the jet to liquid gap is decreased and diminished when the viscosity of the liquid is increased.

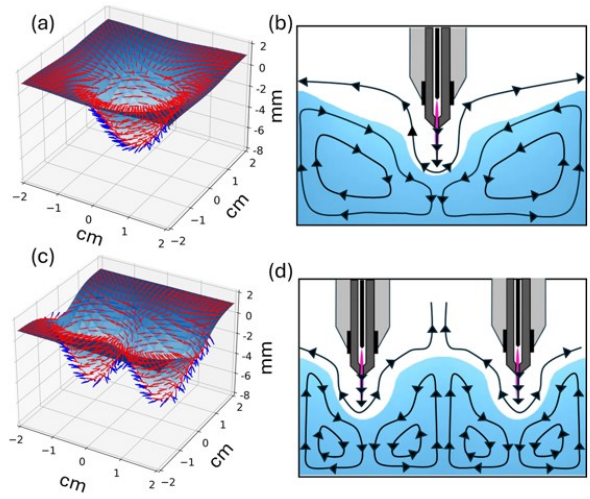

Fig (a) CFD simulation **(b)** flow visualization over a surface exposed to single plasma jet and (**c)** CFD simulation **(d)** flow visualization over a surface exposed to dual vertical plasma jets.

Additionally, liquid phase NO_x synthesis is favoured by shallow depth catalyst locations; nitrate yields are increased by 37% and 25%, respectively, by heterogeneous CeO_2 and homogeneous $[Co(NH_3)_6]Cl_3$ catalysts. These results collectively demonstrate how catalyst proximity, reactor configuration, surface geometry, and jet momentum work in concert to guide the design of continuous-flow, energy-efficient plasma reactors for sustainable plasma-liquid interaction.

Reference:

[1] Pho Q H, Hessel V, Rebrov E V, Long N V D, Lamichhane P, Tran N N and Losic D 2024 Stagnant liquid layer as “Microreaction System” in submerged plasma Micro-Jet for formation of carbon quantum dots *Chem. Eng. J.* **495** 153571