SUSTAINABLE CHEMICAL SYNTHESIS THROUGH PLASMA-LIQUID INTERACTIONS IN A HELICAL DIELECTRIC BARRIER DISCHARGE MICROREACTOR

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ABSTRACT

Non-thermal plasma processing is gaining momentum as a novel and greener chemical synthesis route due to its ability to perform reactions beyond thermodynamic limitations at ambient conditions using electrical energy. Plasma microreactors integrate microflow with discharges in submillimeter scale, enabling a highly reactive environment at mild operating conditions and low energy input. This unique combination is particularly beneficial for plasma-liquid interactions due to the enhanced interfacial area between phases and mass transfer at the microscale [1]. Biphasic plasma microreactors operating at atmospheric pressure are usually complex and rely on microfabrication procedures. In this work we introduce a simple and modular microreactor design based on an AC-driven, helical dielectric barrier discharge (DBD) in a coaxial configuration, that enables high interfacial area, adjustable residence time of the gas and liquid streams, and high productivity of valuable molecules. From inert gas plasmas in contact with deionized water we managed the synthesis of hydrogen peroxide (H_2O_2) at high concentrations and energy efficiency [2]. Argon plasma with ethane (C_2H_6) admixtures in contact with water resulted in the synthesis of valuable gases like hydrogen (H_2) and ethylene (C_2H_4) as well as high-value liquid oxygenates like methanol (CH_3OH), ethanol (C_2H_5OH) and acetic acid (CH_3COOH) [3]. Finally, Ar / O_2 discharges in contact with long-chain liquid alkane streams led to the oxidative functionalization to added-value oxygenates like alcohols and ketones at significant yields and low energy input.

KEYWORDS: Plasma discharges, green chemical synthesis, biphasic microreactor, oxidative functionalization, hydrogen peroxide

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