Plasma-activated polymerisation in a liquid-gas microreactor

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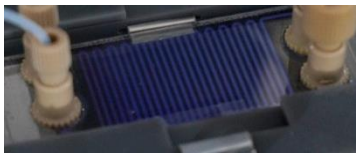
The aim of our project is to produce liquid polymers of industrial interest using dielectric barrier discharges (DBD) in liquid-gas plasma micro-structured reactors. This technology will allow the development of innovative polymers, cleaner chemical routes, limiting the number of steps and the consumption of solvents and catalysts.

It is quite a challenge to achieve both high conversion and high selectivity with traditional plasma systems for polymerization or organic synthesis [1, 2]. To overcome this difficulty, we combine plasma technology to microfluidics in this project. Indeed, microfluidic technologies allow an unprecedented control of the chemical and physical environment of the reaction, and thus, as we expect, a better selectivity and conversion.

The work presented here has been performed in a gas-liquid glass microreactor designed to obtain a stabilized side-by-side flow of both liquid monomer and gas. Electrodes are coated on each sides to sustain a double DBD discharge inside the gas flow thanks to a high voltage AC generator.



Microréacteur Biphasique "Biflow 2.7"

The residence time is about 1 minute, with a power of several hundreds of mW (20kV AC, 1kHz, Argon). The fast extraction of the product by the liquid phase avoids polymer clogging, and plasma parameters (signal frequency, amplitude, etc.) modulation allows us to control the radical production rate.

1-hexene was chosen as a model molecule/proof of concept in this project. Mixed with various vector gases, 1-hexene was polymerized in short chains – 5 to 6 monomers – with a conversion of 20%, under various discharge conditions with a very good repeatability. We also had first proofs of oxygen integration in the polymer – ketones.

[1] Wandell, R. J., Bresch, S., Hsieh, K., Alabugin, I. V. & Locke, B. R. "Formation of Alcohols and Carbonyl Compounds From Hexane and Cyclohexane With Water in a Liquid Film Plasma Reactor". *IEEE Trans. Plasma Sci.* **42,** 1195–1205 (2014).

[2] Paulussen, S., R. Rego, O. Goossens, D. Vangeneugden, et K. Rose. « Plasma Polymerization of Hybrid Organic–Inorganic Monomers in an Atmospheric Pressure Dielectric Barrier Discharge ». *Surface and Coatings Technology* 200, nº 1-4 (octobre 2005): 672-75.

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