Hydrogen production from ammonia cracking using a dielectric barrier discharge assisted by catalysis under atmospheric pressure

Thibault Queeckers[a,b], David Petitjean[a], Delphine Merche[a], Eric Gaigneaux[b], François Reniers[a]

Contact: Thibault.queeckers@ulb.be

[a] *Chemistry of Surfaces, Interfaces and Nanomaterials (ChemSIN), Université libre de Bruxelles, Belgium*
[b] *Molecular Chemistry, Materials and Catalysis (MOST), Université catholique de Louvain, Belgium*

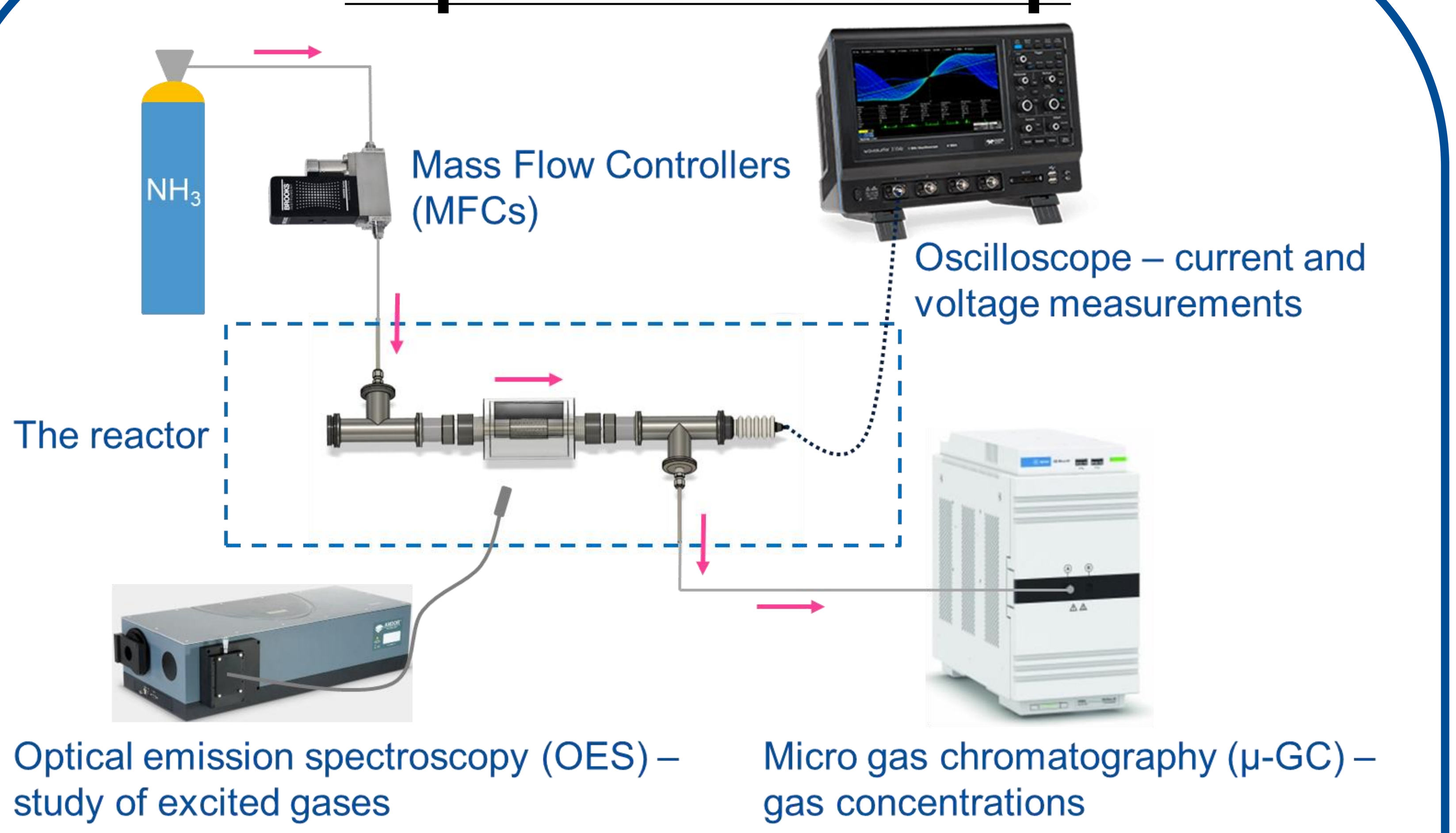
Introduction

Ammonia is emerging as a key hydrogen carrier for transport and renewable energy. To recover hydrogen efficiently, we developed a dielectric barrier discharge (DBD) plasma reactor for ammonia cracking at room temperature and atmospheric pressure.

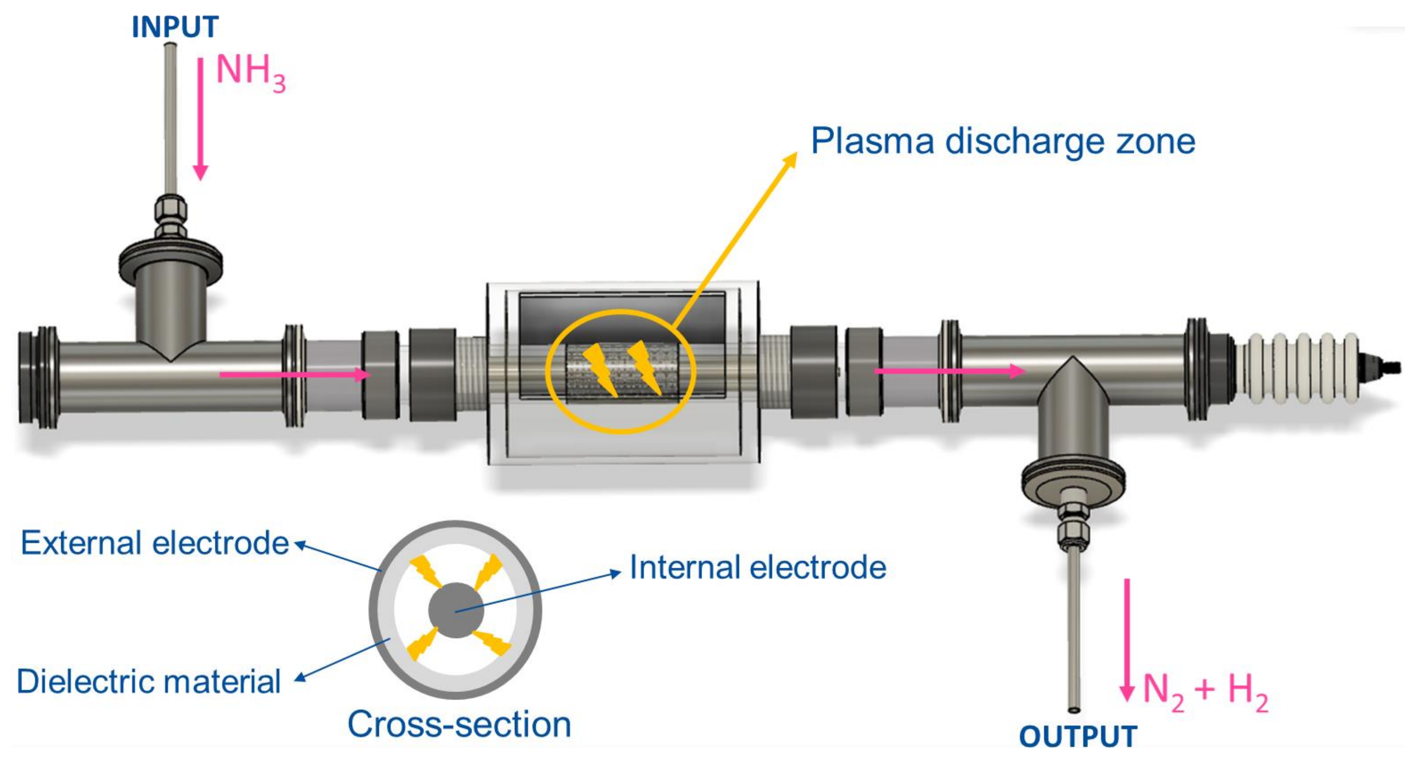
$$2\ NH_{3(g)} \xrightarrow{+e^-} 3\ H_{2(g)} + N_{2(g)}$$

This carbon-free process enables on-demand hydrogen production, and its performance can be further improved through plasma–catalyst synergy.

Experimental setup

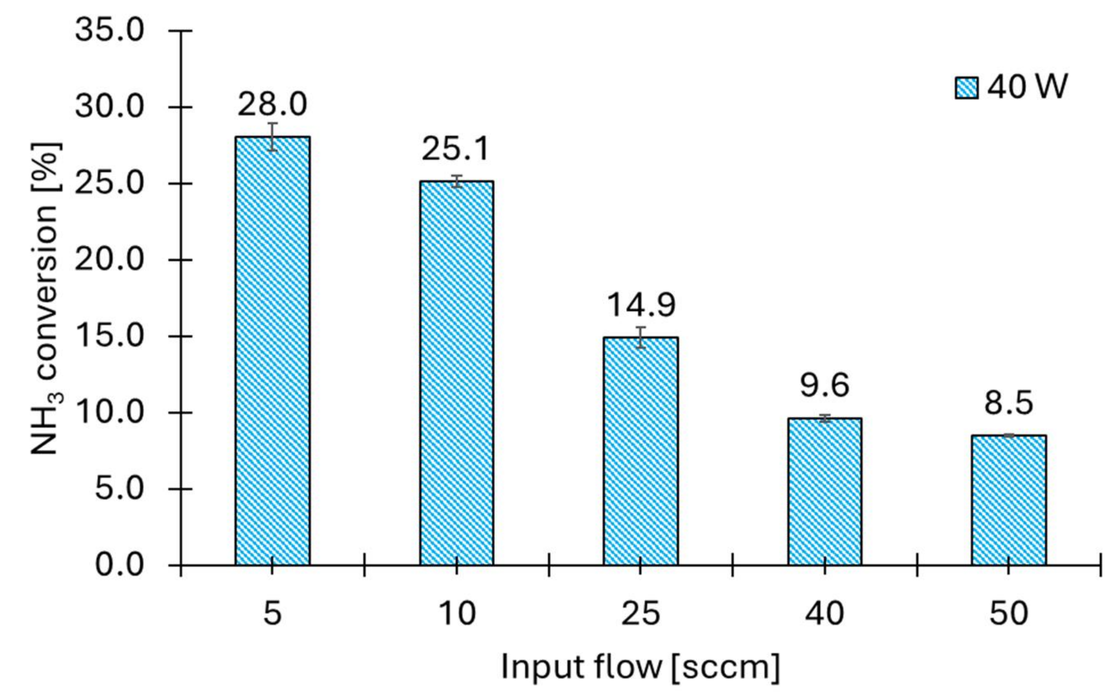


High concentration of ammonia is fed into the dielectric barrier discharge reactor, where it is converted into hydrogen and nitrogen by the plasma. The outlet gases are analyzed by micro gas chromatography (µ-GC) to determine the ammonia conversion.

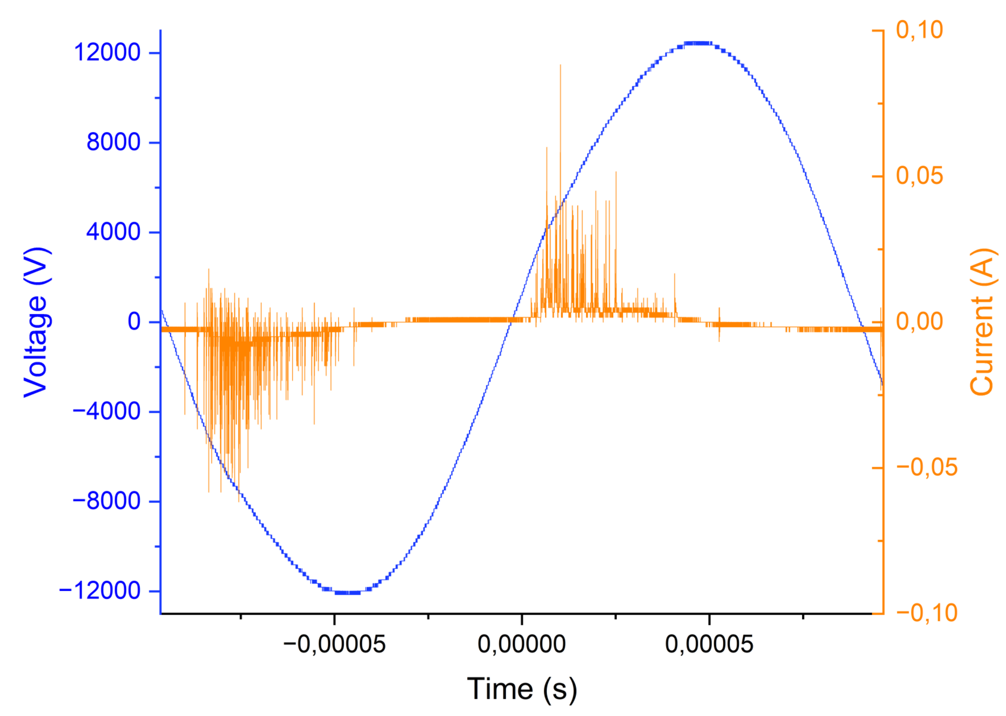


Plasma is generated by applying a high-voltage signal between the two electrodes, one of which includes a dielectric material. The resulting discharge is performed at atmospheric pressure and room temperature, and can be characterized using various diagnostic techniques, such as optical emission spectroscopy (OES) and oscilloscope measurements.

Results



Studying ammonia conversion together with discharge characteristics provides valuable insights into the fundamental plasma behavior and supports the optimization of operating parameters.



Perspectives and valorization

- Optimize operating parameters of the plasma-powered reaction to minimize energy cost.
- Synthetize and implement custom catalysts to enhance performance through plasma–catalyst synergy.
- Understand the underlying behavior of the plasma–catalyst synergy.
- Benchmark the process for efficient, on-demand green hydrogen production at low energy cost.

Acknowledgements

The authors thank the Walloon Region for launching the Win4Excellence project and funding the research.