Plasma-Catalytic Ammonia Decomposition using a Packed-bed Dielectric Barrier Discharge Reactor

Supporting Information

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1 Q-V figures for tested materials

As explained in the experimental section of the article, the electrical data were recorded by a digital oscilloscope (Picotech, Picoscope 6402C) during the ammonia decomposition. Figures S1, S2, and S3 display the recorded data of applied voltage (V) and generated charges (Q) for all the materials tested and were used to determine the capacitance of the cell (reactor + gas) (C_{cell}), the effective capacitance (ζ_{diel}), and the displaced charges (Q_d).

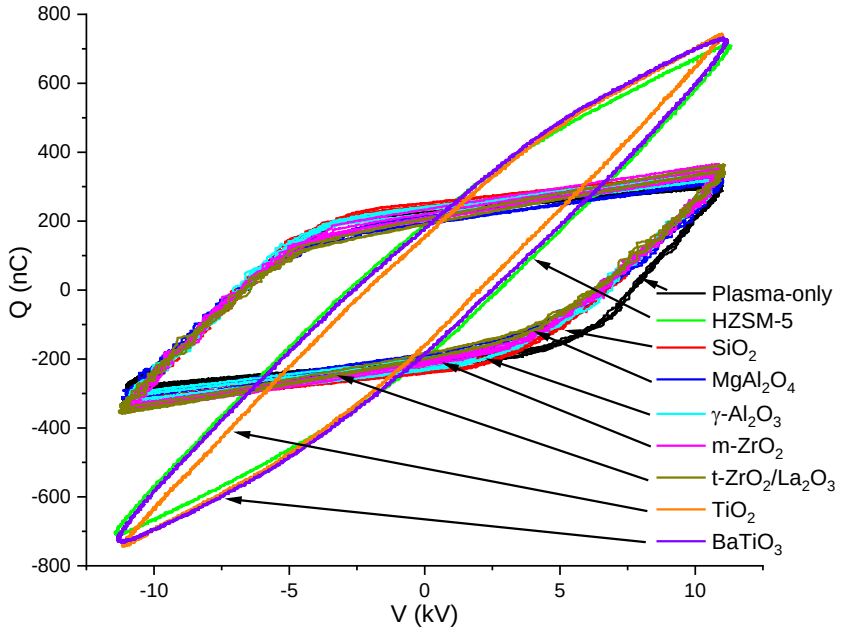

Figure S1 - Lissajous curves obtained from the NH_3 decomposition with dielectric materials.

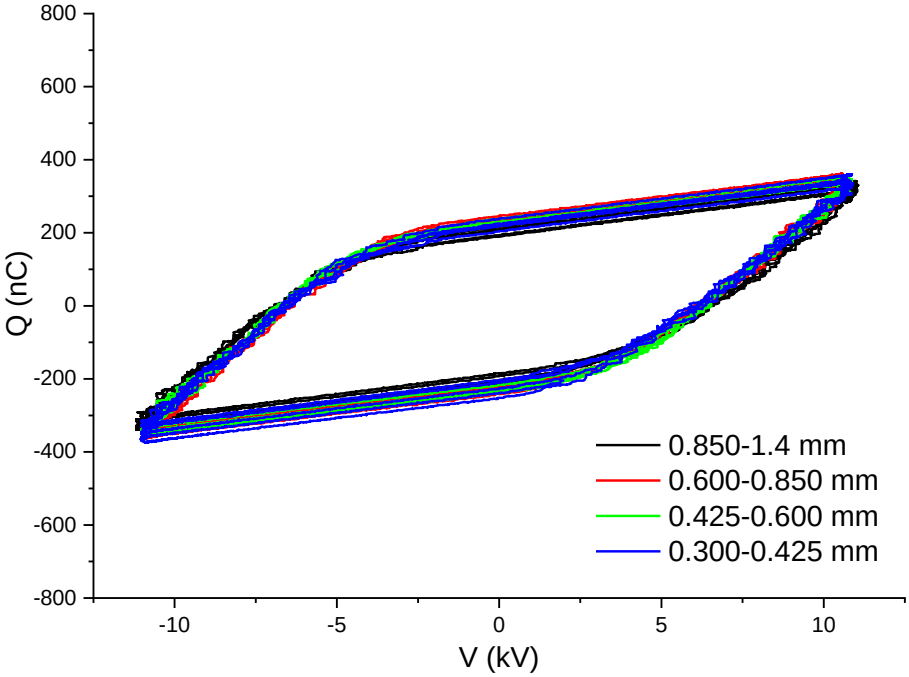

Figure S2 - Lissajous curves for the different particle sizes of $MgAl_2O_4$.

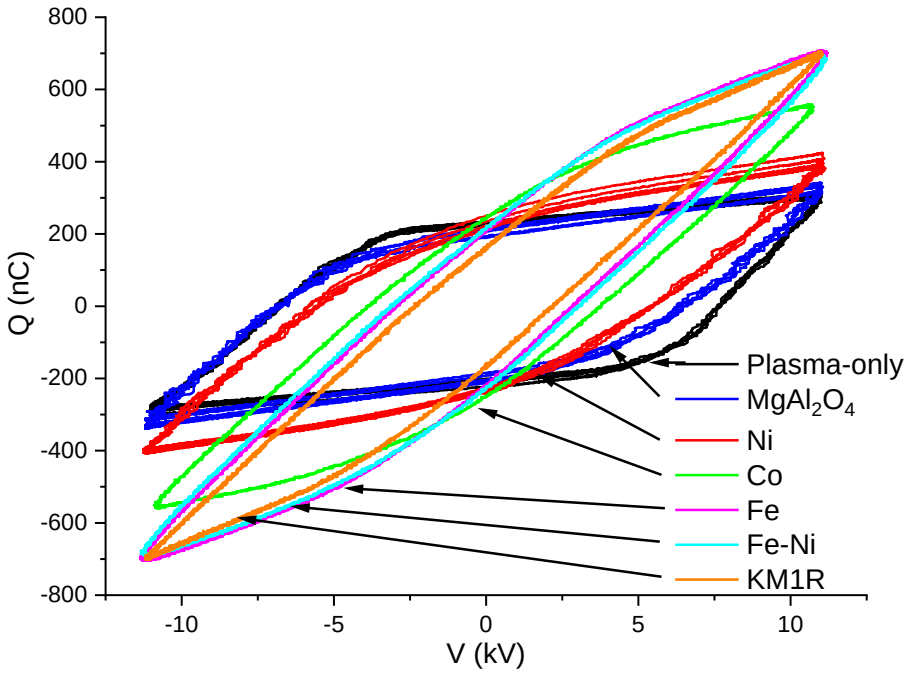

Figure S3 - Lissajous curves for the different metal impregnations of $MgAl_2O_4$.

2 Effect of flow rate

To investigate the effect of residence time, the feed flow rate was changed. It must be mentioned that the specific energy input (SEI), i.e. power per volumetric flow rate, was thus also changed, which also could have an influence on the conversion. However, the change in flow rate gives an indication of the effect of residence time. The flow rate was varied from 50 to 100 Nml/min with a constant plasma power of 21 W and with $MgAl_2O_4$ as packing material. When changing the flow rate from 50 to 75 to 100 Nml/min, the residence time changes from 2.6 to 1.7 to 1.3 s. From Figure S4 it can be observed that the conversion decreases with increasing flow rate, hence a lower residence time results in a lower conversion, more specifically the conversion changes from 12.6% at 1.7 s to 10.1% at 1.3 s.

With regard to the change in residence time caused by the temperature increase, the residence time changes from 2.0 s at 135°C to 1.6 s at 235°C with a conversion decrease of 12.6% to 9.92%. This alteration in conversion (ca. 2.7% point) correlates well with the one observed from the feed flow change and is thereby likely caused by the change in residence time.

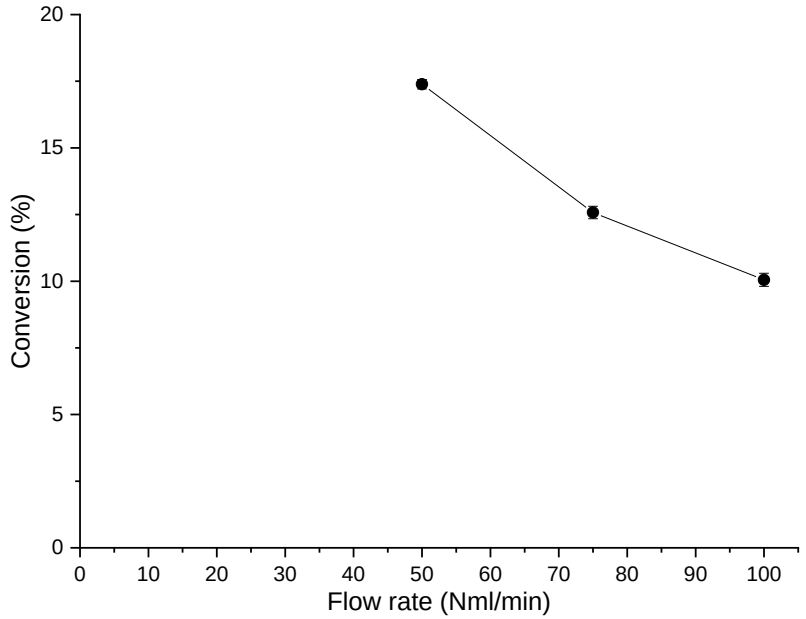

Figure S4 – Effect of feed flow rate on ammonia conversion with $MgAl_2O_4$ in plasma zone (21 W, 3 kHz, and 4.5 mm gap).

3 Effect of introducing metal-containing materials in plasma

Figure S5 show the correlation between the number of micro-discharges per half period and the NH_3 conversion, including the results obtained for the metal containing materials (red points).

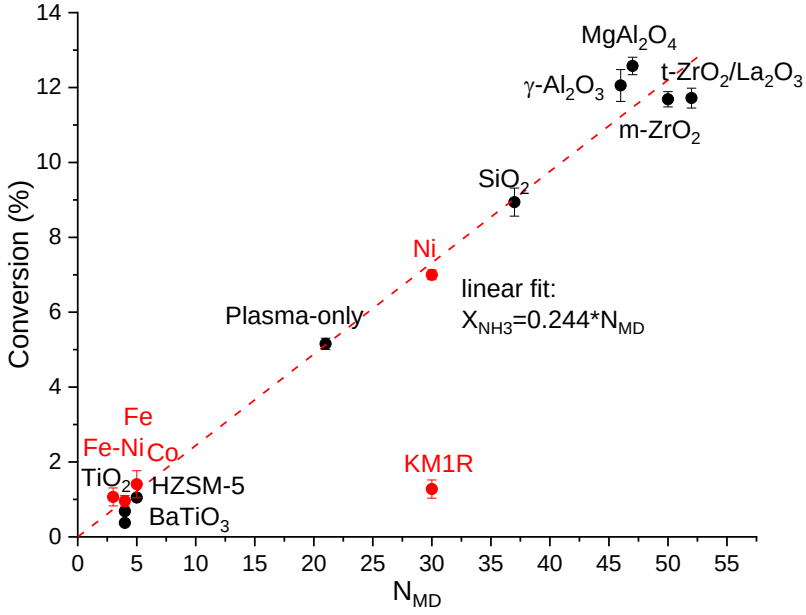

Figure S5 - NH_3 conversion as function of the number of micro-discharges per half period.