L3 | Process for the plasma catalytic removal of O_2 traces from steel mill gases

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One opportunity for the optimization of catalytic conversions is the combination with non-thermal plasma referred to as plasma catalysis. The plasma species might allow the catalytic conversion at lower process temperatures. This has a potential for energy conservation, if the plasma consumes less energy compared to the savings by reduction of the process temperature. This potential of plasma catalysis is examined for the O_2 trace removal in steel mill gases as coke oven gas.

METHOD

A test rig was installed for the plasma catalytic treatment at Fraunhofer UMSICHT. The designed plasma catalytic reactor is based on the packed-bed DBD setup (Figure 1).

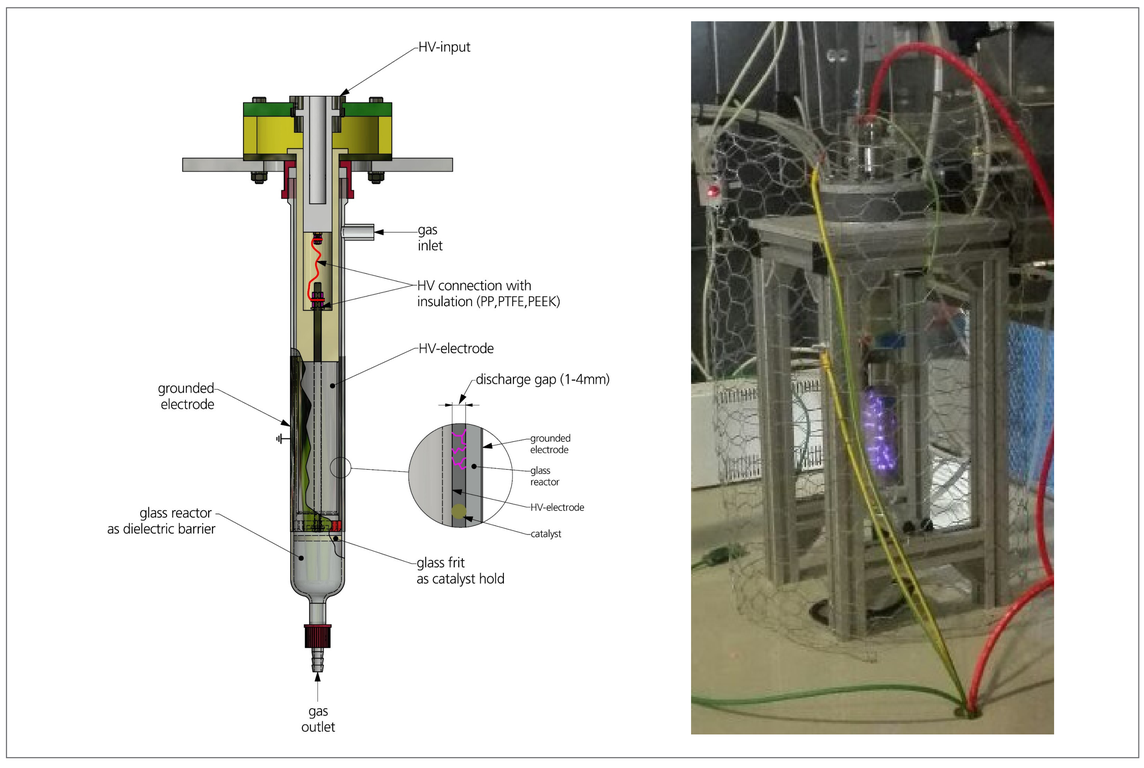

Figure 1: packed-bed DBD reactor

The volumetric flow rate within the tests was approx. 0.1 Nm^3/h, which results in a GHSV of 2000 - 4000 h^{-1} in the discharge zone. The gas consists of 0 – 60 % H_2, O_2 traces in the range of 500 – 1500 ppm with N_2 in balance. The O_2-concentration is measured by an electro-chemical sensor, a change of the other main gas components is measured by TCD (H_2) and IR (CO, CO_2, CH_4).

RESULTS AND CONCLUSIONS

Several experiments are conducted with variation of the raw gas compositions as well as the variation of the plasma catalytical treatment. The results of this variation (Figure 2) indicate, that O_2 can be converted with non-thermal plasma partially and catalyst completely as long as CO is not present. Otherwise the catalyst is deactivated. A combination of non-thermal plasma and catalyst increases the conversion outcome in presence of CO.

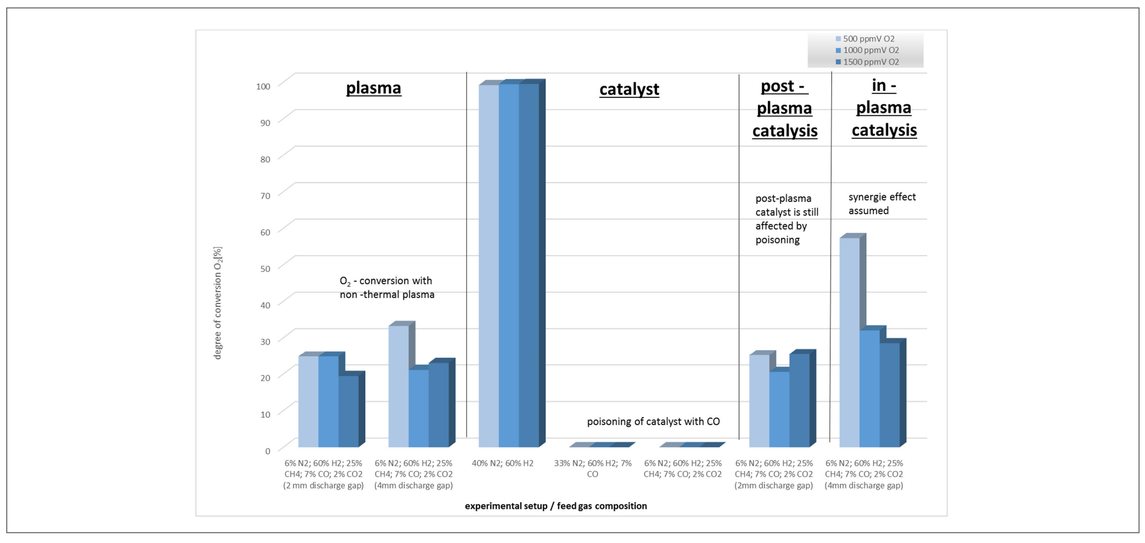

Figure 2: results of O_2 conversion in model steel mill gas

Plasma catalysis is a promising approach for the optimization of the O_2 trace removal. This potential will be validated in further experiments with an optimized packed-bed DBD as well as other plasma catalytic reactor setups (corona discharge from Fraunhofer UMSICHT and surface DBD from Ruhr-University Bochum).

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CO_2 reduction through cross-industrial cooperation between the steel, chemical and energy industries