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Electrochemical removal of NO_x using solid oxide cells

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Nitrous oxides (NO_x) are harmful emissions from high temperature combustion processes, especially from Diesel engines, which are becoming more popular in the recent years. The techniques normally used for reducing NO_x under an oxygen rich environment are the selective catalytic reduction (SCR) with ammonia/urea and the NO_x storage and reduction (NSR). The implementation of these technologies are not straight forward since dosing equipment for the reducing agent in SCR and careful control of the engine in NSR is needed.

In electrochemical cells based on an oxide ion conducting electrolyte, NO_x can be reduced at the cathode and the oxygen extracted can in principle be used to oxidize soot particulates at the anode. Such an electrochemical filter will operate much simpler than the catalytic techniques used so far.

At DTU Energy, extensive research has been performed during the recent years to develop electrodes and electro-catalysts for NO_x reduction in solid oxide cells operating between 300 – 500 degrees Celsius and also to investigate the effect of simultaneous NO_x and soot removal. The main challenge in the electrode development is to suppress the parasitic oxygen reduction at very low NO_x contents. Thus, besides selectivity the current efficiency of the electrochemical NO_x reduction is a crucial parameter in the evaluation of the electrochemical NO_x filters.

A promising strategy is to impregnate porous electrodes based on La-Sr manganite or La-Sr-cobaltite with getter materials for NO_x (NO_x storage compound) (1) or other active NO_x reducing catalysts as well as introducing a NO_x adsorption layer (2) in the vicinity of the NO_x reducing electrode. High selectivity (80-100%) towards the reduction of NO_x to N₂ and current efficiencies of above 12% have been achieved (1,2). Current activities are related to optimize the porous structure of the cells (3) and to derive a better understanding of the interaction of NO_x with the electro-catalysts by applying visible light Raman spectroscopy onto working solid oxide cells (4).

The contribution will review the results obtained so far and outline the technological perspectives and challenges for electrochemical NO_x filters in general.

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