Dynamic catalyst operation for enhanced low-temperature pollutant conversion

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Although modern optimized catalyst formulations commonly enable efficient pollutant conversion over a broad range of reaction conditions, pollutant activation in the low-temperature regime remains challenging, especially in complex gas mixtures. In the present work, palladium-based catalysts are operated dynamically in order to enhance their low-temperature activity for conversion of gas species such as hydrocarbons (HCs), carbon monoxide (CO), and nitrogen oxides (NO_x). Dynamic operation is beneficial both under lean (excess oxygen) as well as under stoichiometric (air-fuel-ratio = 1) conditions. For instance, the introduction of short reducing pulses (temporary oxygen cut-off) during otherwise lean catalyst operation allows for decreasing T_{50} (= temperature of 50% conversion) of CH_4 oxidation by more than 100°C compared to static lean conditions. Similarly, a substantial increase in HC, CO, and NO_x conversion as well as reasonable product selectivity can be achieved if parameters such as frequency, amplitude, and average air-fuel-ratio are optimized during fast lean-rich cycling (*c.f.* Fig. 1).

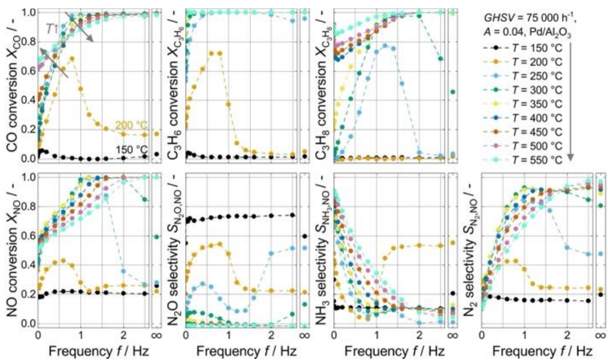

Figure 1: Average pollutant conversion and selectivity of products formed from NO at different frequencies and temperatures at constant space velocity (75 000 h^{-1}) and amplitude (0.04) on a monolithic Pd/Al_2O_3 catalyst.[2]

[1] K. Keller *et al.*, Catal. Sci. Technol., 2024, accepted, DOI: 10.1039/D4CY00625A.
[2] D. Hodonj *et al.*, Appl. Catal. B, 2024, **345**, 123657.