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Experimental heat release rate imaging during flame-wall interactions by simultaneous CH_2O/OH-PLIF measurements

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In this study, relative heat release rate (HRR) distributions of stoichiometric premixed dimethyl ether (DME) flames are experimentally investigated during atmospheric side-wall quenching (SWQ), to provide both an improved understanding of phenomena in flame-wall interaction (FWI) and validation data for numerical simulations. For premixed flames of hydrocarbons, HRR correlates well with the product of the relative species concentrations of formaldehyde (CH_2O) and the hydroxyl radical (OH) [1]. Relative concentrations of these species can be imaged experimentally using planar laser-induced fluorescence (PLIF) to derive HRR and reaction zones by calculating the local product $S_{\mathrm{CH_2O}} \times S_{\mathrm{OH}}$ of the corresponding PLIF-signals [2,3]. A generic SWQ-burner setup [4] with well-defined boundary conditions is used, where one branch of a V-shaped flame, stabilized on a ceramic rod, interacts with a water-cooled stainless steel wall.

Preliminary results of stoichiometric DME flames under laminar and turbulent flow conditions show high CH_2O PLIF signals even very close to the quenching-wall. In contrast, the OH-signals decrease more rapidly when the flame approaches the wall. Broadening of the CH_2O distribution and flattening of the OH-signal gradient indicate a change in the flame structure within the FWI-zone. These findings are similarly made for laminar and turbulent flow conditions. In our ongoing study investigations will be extended to methane flames, a variation of equivalence ratios and different wall temperatures. Flame structures and reaction thicknesses in the flame-wall interaction zone will be analysed quantitatively.

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