

Fiber Laser Intracavity Absorption Spectroscopy (FLICAS) Thermometry for Combustion Diagnostics

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Gas sensors based on absorption spectroscopy are attracting great interest in a variety of combustion-related applications. Accurate and (desirably) simultaneous measurements of CO, CO₂, CH₄, and H₂O, along with non-invasive temperature determination (see for example Figure 1) is crucial for evaluation of combustion completeness and other environmental and performance aspects of combustion and gas-reforming devices.

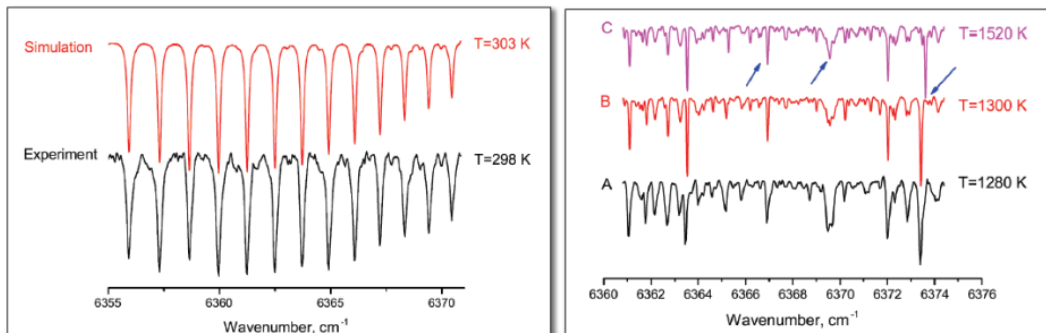


Figure 1: Left panel: FLICAS spectrum of CO₂ at room temperature along with simulation; Right panel: FLICAS spectrum of water vapors (A) at 1280 K along with simulation using original HITEMP database (C) and the modified one (B) (shifted lines shown with arrows), indicating the deficiencies of the spectral database.

Here we report a methodology for concentration measurements of CO, CO₂, CH₄, and H₂O and thermometry based on broadband detection of these species. For this purpose we use a fiber laser intracavity absorption spectroscopy (FLICAS) based on an Erbium doped broadband laser capable of being tuned in the range of 6350-6450 cm⁻¹. The experiments were performed in a temperature controlled flow-cell, which allowed to evaluate the feasibility of the FLICAS technique for temperature and concentration diagnostics

We have found that CO and CO₂ spectra are well described by HITRAN database allowing for accurate and simultaneous determination of temperature and concentration.

Our study demonstrates that for CH₄ and H₂O the deficiencies of HITRAN database (especially for high temperature conditions) somewhat limit the use of these molecules as candidates for thermometry in combustion related devices.