Dynamic gas-solid surface interactions for dry reforming of methane via in-situ DRIFTS analysis

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In this note: Monitoring surface species on a nanorod catalyst for dry reforming of methane

Dry reforming of methane (DRM) is a key process for converting CH_4 and CO_2 into valuable syngas (CO and H_2).[1–3] Understanding gas-solid surface interactions during DRM is essential for the rational design of catalysts.

Here, in situ Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) using the Harrick Praying Mantis™ accessory and a high-temperature reaction chamber (HVC-DRM-5) are employed to track surface species on a 1.5 wt% Ni–0.5 wt% Ru/CeO_2 nanorod (NR) catalyst over a temperature range of 50°C to 450°C.

Experimental

Catalyst preparation

The 1.5 wt% Ni–0.5 wt% Ru/CeO_2 NR catalyst was synthesized via a one-pot hydrothermal method, ensuring uniform dispersion of Ni–Ru on the CeO_2 NR supports.

Instrumentation

In situ DRIFTS was performed with the Harrick Praying Mantis diffuse reflection accessory along with a high-temperature reaction chamber, integrated into a Thermo Scientific™ Nicolet™ iS50 FTIR Spectrometer system (Fig. 1), providing precise temperature and gas flow control for real-time monitoring of surface gas-solid reactions.

Reaction conditions

A CH_4/CO_2 gas mixture (29:71 ≈ 0.4 ratio) was fed at a total flow rate of 100 sccm. The temperature was ramped from 50°C to 450°C at 10°C/min, with spectra collected every 50°C after stabilizing the gas flow and temperature for 15 min.

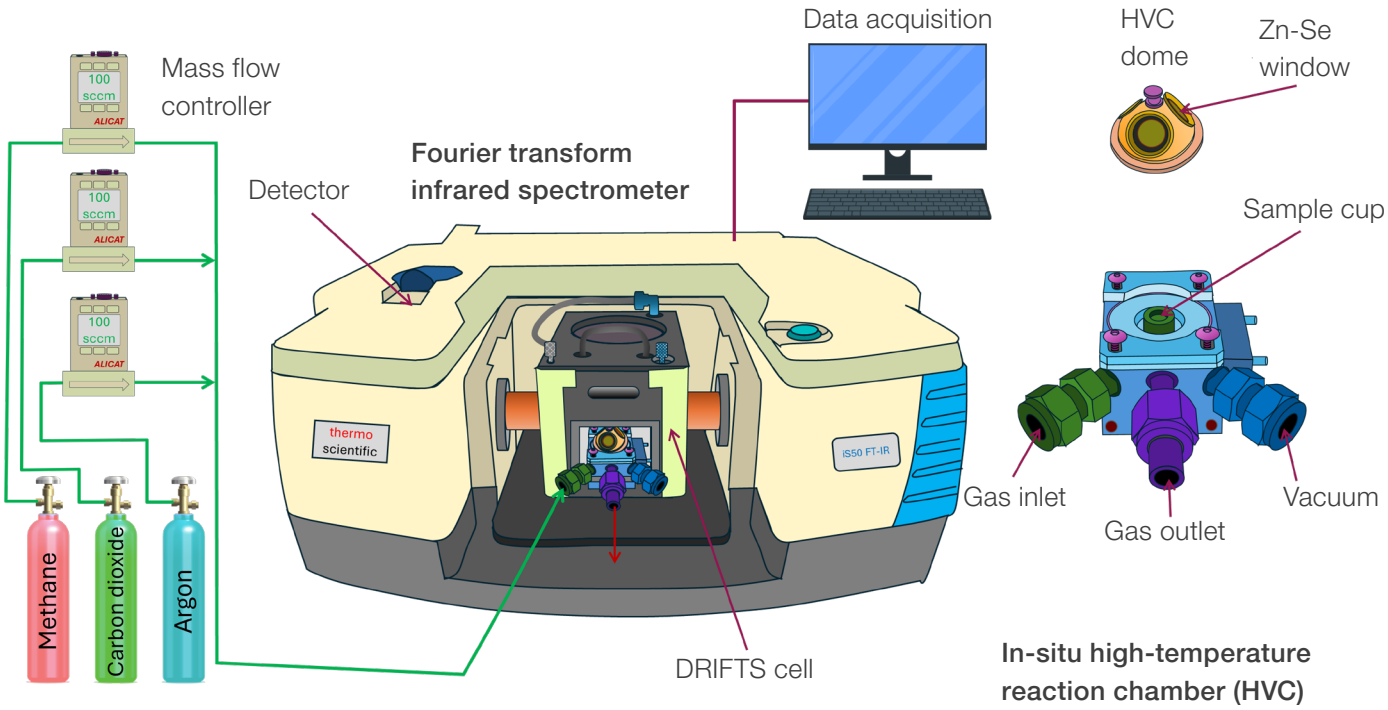

Figure 1. Experimental setup for in-situ DRIFTS using a Harrick Praying Mantis Cell and a high-temperature reaction chamber.

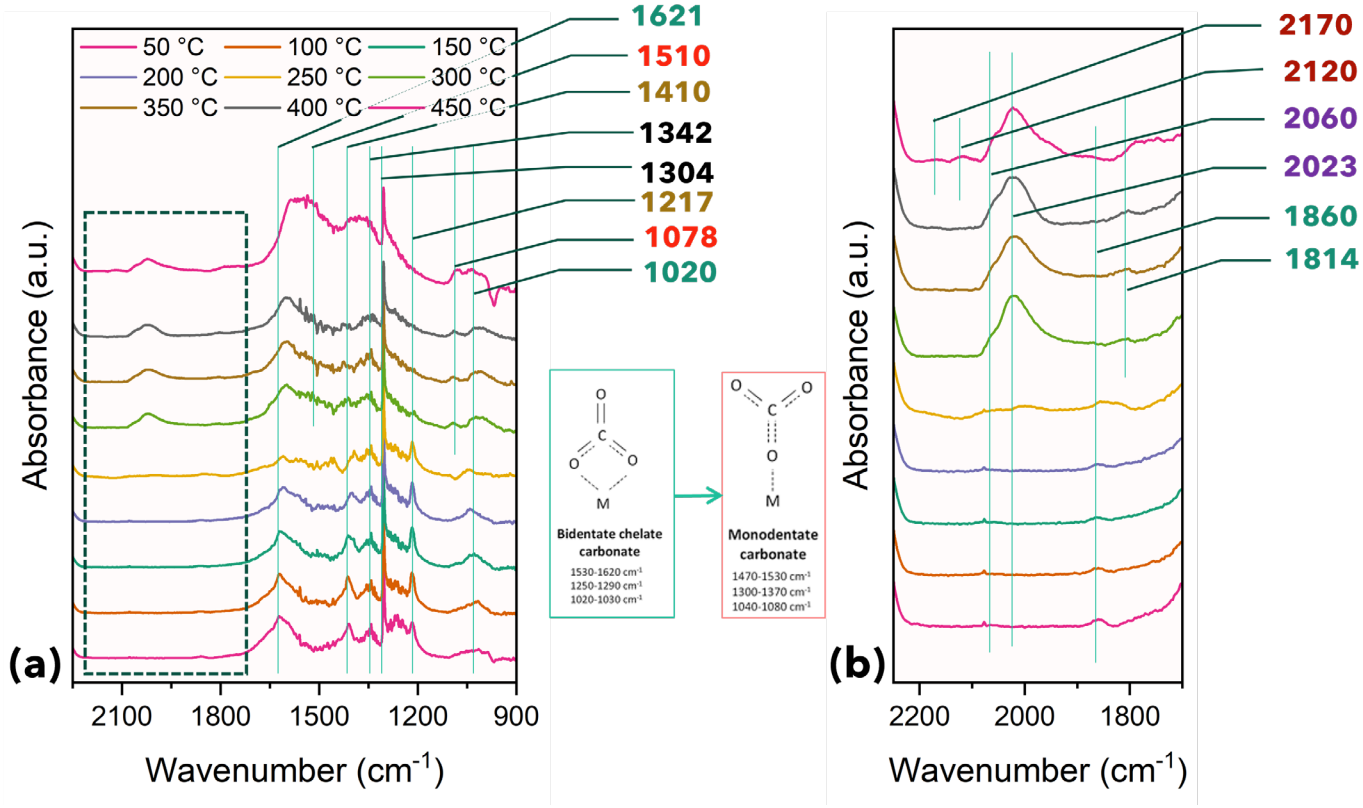

Figure 2. In situ DRIFTS spectra for DRM at varying temperatures (CH_4/CO_2 = 29/71 sccm ≈ 0.4 ratio; total flow rate: 100 sccm).

Conclusion

The in situ DRIFTS investigation with the Harrick Praying Mantis setup revealed the evolution and transformation of surface species during DRM on Ni–Ru/CeO_2 NRs. The findings demonstrate the power of in situ DRIFTS's ability to elucidate catalytic mechanisms and highlight the promising performance of this catalyst for DRM.

Acknowledgement

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