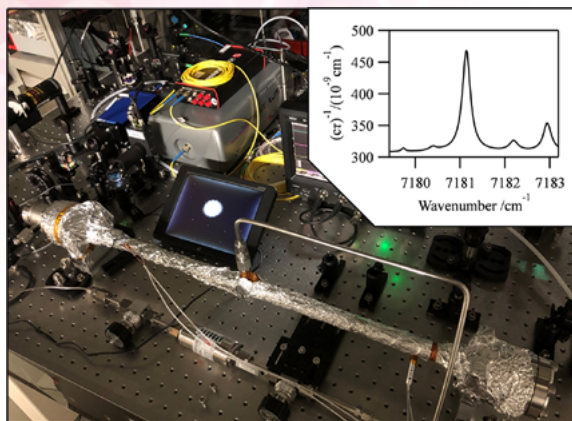


High-sensitivity detection of trace moisture in gas using wavelength-meter-controlled cavity ring-down spectroscopy

HASHIGUCHI Koji

There is an increasing demand for accurate measurement of trace water vapor (trace moisture) in gases in technology-intensive industries. Therefore, NMIJ has developed measuring instruments for measuring trace moisture using cavity ring-down spectroscopy (CRDS). In CRDS, an optical cavity consisting of highly reflective mirrors is used as a sample cell to extend the effective optical path length. However, it becomes more difficult to transmit a probe laser through the cavity if we use higher reflectivity mirrors. To solve this issue, we developed a simplified technique for laser control in CRDS, referred to as the “wavelength-meter-controlled” technique, and acquired the absorption spectra of H₂O with good long-term stability. In wavelength-meter-controlled CRDS, first, resonant frequencies of the cavity are stabilized with reference to

the frequency of a helium-neon (He-Ne) laser. Then the frequency of the probe laser is controlled to adjust to one of the stabilized resonant frequencies using a high-resolution wavelength meter. By following these steps, we enabled the use of highly reflective mirrors. With this new technique, we were able to acquire the absorption spectra of trace moisture near 7180 cm⁻¹ at atmospheric pressure with parts-per-trillion sensitivity, which is the highest level of detection sensitivity for trace moisture measurement in the world. In addition to the development of the measurement device, we are aiming at achieving precise measurement of trace moisture by evaluating the optimal line shape profiles for fitting the absorption spectra.



The wavelength-meter-controlled cavity ring-down spectroscopy. Inserted graph on the upper right corner is the absorption spectrum of trace moisture.

Reference: K. Hashiguchi et al., *Jpn. J. Appl. Phys.* **61**, 012003, 2022, DOI: 10.35848/1347-4065/ac3724