



Methane gas detection based on wavelength modulation off-axis integrated cavity output spectrometer

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An instrument of off-axis integrated cavity output spectrometer combined with wavelength modulation Spectroscopy (WMS-OA-ICOS) for methane (CH₄) gas detection was developed. The modulation parameters, such as the modulation amplitude, modulation frequency, reference phase, time constant of lock in amplifier, the laser scanning voltage and the laser scanning frequency, were optimized to obtain the second harmonic peak-height. The CH₄ concentration measurements were obtained by the following two methods: the second harmonic ($2f$) and the first harmonic normalized second harmonic ($2f/1f$). The dynamic range and linearity of WMS-OA-ICOS for two methods were also investigated. The result showed that the $2f/1f$ method exhibited better linearity than $2f$ method. Compared with the traditional off-axis integrated cavity output spectroscopy (OA-ICOS) technique, WMS-OA-ICOS provided an 8-fold improvement in detection sensitivity.