

Broadband Absorption Spectrometers Using LED for the Detection of NO₂, NO₃ and N₂O₅

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We developed a three channel IBBCEAS instrument for simultaneous measurement of NO₂, NO₃ and N₂O₅. For all channels, we used single color LED from LedEngin as light source and Ocean Optics QE65000 as detectors. In characterization experiments, we tried HR mirrors with 99.99% (in some cases 99.999%) reflectivity from Layertec, CRD optics and Sigmakoki. We calibrated the mirror reflectivity with pure nitrogen and helium, and the calibration results were further validated by observation of NO₂ compared to a commercial CLD NO₂ instrument. The spectral analysis is currently achieved by DOASIS but we are also developing an IDL software package for fast and on-line data analysis based on SVD algorithm. In the lab, if we produce NO₃ inside the cavity, the optical detection limit is found to be around a few ppt. In field test experiments, we recognized that the detection limit are strongly degraded by other factors and there were several major issues we have to overcome to deliver meaningful results of both NO₃ and N₂O₅. First is to minimize the losses on the aerosol filters especially the urban air in China is mostly with high aerosol loadings. Second is to minimize the inlet and cavity losses of them. Third is to subtract the extinction of H₂O correctly and precisely. To overcome the first and the second problems, we are developing an automatic filter exchanger, a new design to shorten the inlet and minimize the cavity volume so that most of NO₃ and N₂O₅ can survive into the cavity. For the third problem, we are setting up a lookup table of the H₂O absorption cross section at different concentrations at room temperature for our current detectors. This lookup table may be extended to other temperature regime according to theoretical calculations. We plan to use the newly developed IBBCEAS system to measure ambient NO₃ and N₂O₅ in both urban and rural Beijing. And therefore, to test and develop the nighttime chemical mechanism under highly polluted Chinese megacity areas.