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Development of a spectroscopic sensor for accurate, real-time monitoring of personal exposure to nitrogen dioxide

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Nitrogen dioxide (NO_2) is a major air pollutant that can lead to increased risks of lung cancer, cardiovascular mortality, and a 50% increased likelihood of children developing asthma. Expanding the scope and range of NO_2 measurements is therefore desirable to quantify NO_2 levels and emissions in different settings. Current research and regulatory instruments are too expensive and bulky for widespread deployment and personal exposure measurements, while low-cost sensors do not have the required sensitivity, accuracy, and response time for many applications.

Here we describe a spectroscopic, optical cavity approach to sensitively quantify NO_2 based on the differential absorption at two nearby wavelengths. The system uses a modulated blue LED, an optical cavity for high absorption sensitivity, and lock-in amplification to measure the light transmitted through the cavity. Careful spectral filtering is needed to remove unwanted wavelengths. We report the system performance and Allan deviation of the system, and compare the system response against a standard IBBCEAS set-up for in situ measurements of NO_2. Strategies to improve the instrument performance and reduce sensor size and cost are discussed.