Portable Laser-Based Sensor for Low-Concentration Benzene Detection in Ambient Air

Madini, Bakur (School: Dar AlFikr Schools)

While benzene is one of the most industrially used chemicals; it also poses environmental and health hazards, such as cancer, even at low concentrations in parts per billion (ppb) per the World Health Organization and the Environmental Protection Agency. Unfortunately, current detection devices are either complicated to use or cannot identity low concentrations of benzene accurately. In contrast, laser-based sensors are compact and have a low limit of detection (LoD). In this research, low concentrations of benzene were detected, for the first time, using an infrared Interband Cascade Laser (ICL) emitting between 3039 and 3040 cm and -1 though utilizing Cavity Enhanced Absorption Spectroscopy (CEAS). A cavity was created using CEAS by placing two highly reflective mirrors (R=99.96%) to improve the sensor's LoD. This increased the absorbance by three orders of magnitude. To test the sensors accuracy, seven gas samples with known compositions were prepared and their concentration measured using the difference between the incident and transmitted intensities. Finally, both the theoretical and measured mole fractions were compared and the ratio between them calculated. The near ideal ratio of 1.0381 ±0.0745 between the two values concludes that an accurate portable laser-based sensor was developed using CEAS with an 8ppb LoD, 12500 better than single-pass. This research will potentially provide a critical step forward in monitoring air quality and detecting leaks with the main benefit of saving the lives of people around danger zones.

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