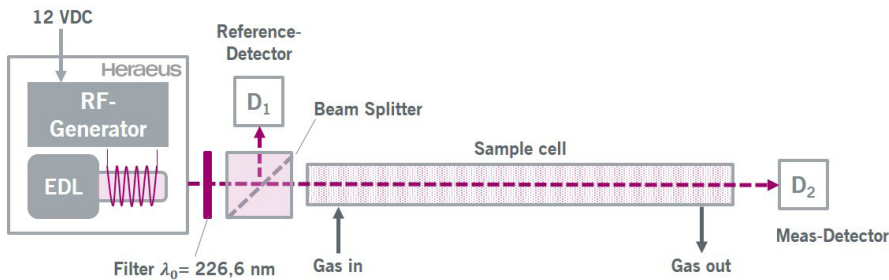




NOx gas measurement module ULTRA.sens® based on the Heraeus NOx Module

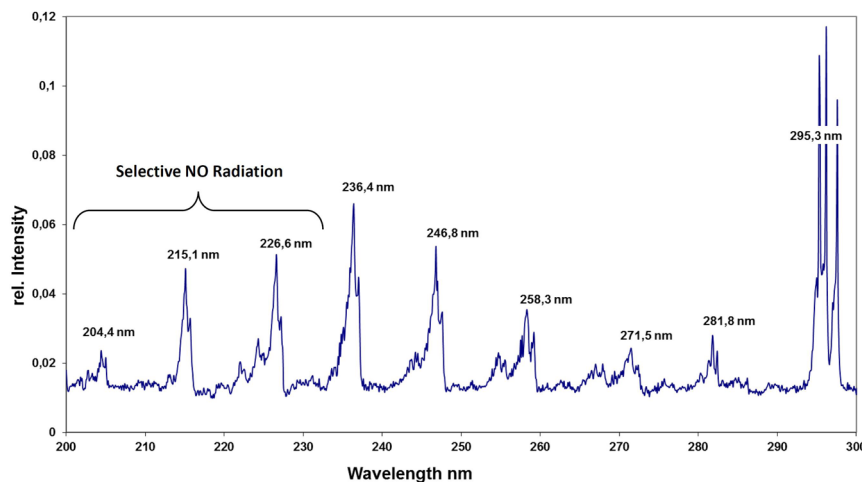
The adverse effects of Nitrogen Oxide (NO) on the environment and human health has placed NO as one of the most important gas types to monitor in the local atmosphere. As the need for mobile monitoring applications such as Portable Emission Monitoring Systems (PEMS) and Continuous Emission Monitoring Systems (CEMS) increase, the demand for small, reliable and precise gas monitoring systems has increased too. Existing technologies used to measure NO include Non-Dispersive Infra-Red (NDIR) and Chemiluminescence Detectors (CLD). However, NDIR has a limited range and is affected by the cross sensitivity to water vapor and other IR active gases, and CLD is costly and requires regular maintenance. On the other hand, the detection of NO using UV is very attractive due to the lack of operating costs and no overlapping of H₂O, CO₂ and CO.

The Heraeus NOx module radiation is based on an Electrodeless gas Discharge Lamp (EDL) with N₂/O₂ gas fill. As shown in the emission spectra the EDL has three selective emission bands for NO (204.4nm, 215.1nm and 226.6nm). 226.6 nm is the most commonly used band for NO detection due to its low cross sensitivity to other gases. To use this emission band, it is necessary to integrate a narrow band pass filter. To achieve a good long term stability of the gas readings, a reference detector is integrated before the sample cell. The reference detector monitors the lamp intensity to compensate the intensity drift simultaneously. The measurement detector receives the attenuated intensity $I(c)$ due to the NO gas concentration c in the sample cell, and it is then possible to calculate the concentration of NO by applying the Lambert-Beer Law.



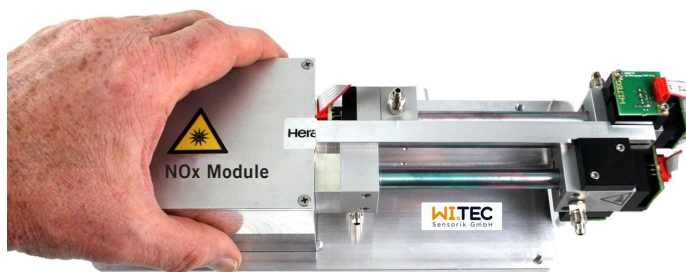
Physical principle of NO detection in the UV range by absorption photometry (Non Dispersive Ultra Violet (NDUV)).

The EDL is powered by a Radio Frequency (RF) oscillator using an inductive excitation coil. The discharge area is connected to a gas reservoir in order to extend the life of the lamp to more than 10,000h in continuous emission monitoring.



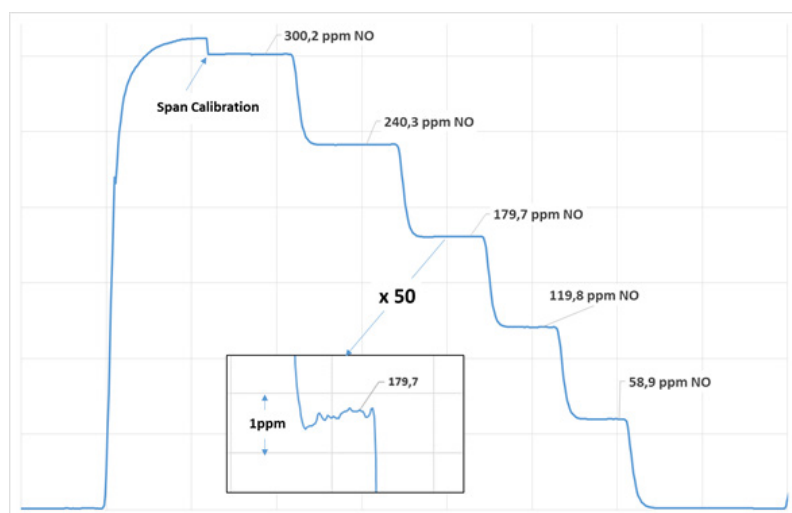
Emission Spectra of the Heraeus NOx-Module in the UV-Range.

Based on this technique the Wi.Tec- Sensorik GmbH in Wesel/ Germany developed a handy gas module called ULTRA.sens®, which is capable of obtaining a detection limit of $4 \cdot \sigma < 0.4 \text{ ppm}$ using a 10 cm stainless steel sample cell with a range of 0-100ppm. Additionally, a separate optical bench for detecting 0-100ppm of SO₂ and 0-100ppm of NO₂ is arranged side by side in the same setup.



ULTRA.sens® setup using the Heraeus NOx Module, an EDL for NO detection in combination with a separate SO₂/NO₂ bench.

The ULTRA.sens® performance test for different NO concentrations is shown in the diagram below. The process started by setting the Nitrogen baseline at zero NO, and the span value to 300ppm NO. The gas concentration was then reduced in a stepwise manner using a precise gas blender. As shown in the enlarged step, at 179.7ppm NO gas reading, the deviation between the expected value and the actual gas reading was less than 1ppm. Similarly, the fluctuation in results at this level was less than 300ppb.



Gas test with different NO concentrations (0ppm → 300ppm → 240ppm → 180ppm → 120ppm → 60ppm → 0ppm)

Features and Benefits of the NOx Module

Plug & Play 12 V

- Simple integration
- Reduced design-in costs
- Easy to replace

NOx specific lines

- Accurate measurement
- High sensitivity

Long lifetime

- 1 year plus for continuous monitoring
- Low cost of ownership
- Long replacement intervals

Application fields

- Environmental monitoring
- Emission control testing
- Smoke stack monitoring
- Marine exhaust monitoring



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