Tunable Diode Laser Spectroscopy (TDLAS)

TDLAS exploits the rotational vibrational absorption features of gases for semiconductor laser-based trace gas detection. Sometimes it is referred to as TDLAS, TLS, TLAS or (with a reference) as TDLARS.

Key features of TDLAS
TDLAS is a very strong tool for highly selective and sensitive measurements. It enables:
- sensitive detection of ppm to ppb (or even ppt!) level concentrations
- in situ measurements
- contactless techniques
- operation at or above room temperature
- measurement of sticky gases
- portable gas detectors

Compared to other highly sensitive technologies, such as gas chromatography TDLAS instruments show
- high selectivity
- low cost of ownership
- fail-safe operation

Concept of TDLAS
TDLAS is one of the most sensitive, selective and robust technologies for trace gas monitoring. It is based on the Lambert-Beer law which states a logarithmic relation between the
- transmission of light through a gas
- product of the attenuation coefficient of the gas
- distance the light travels through the gas

When a gas has an absorption feature at a specific wavelength, the transmitted intensity declines exponentially with:

\[ I(\nu,t) = I_0(\nu) e^{-S(T)g(\nu,\nu_0)nL} \]

With \( n \) being the number density of the molecular absorbers, \( I_0(\nu) \) the initial laser intensity and \( I(\nu,t) \) the intensity detected after the probe with an absorption length \( L \).

The absorption line profile is characterized by the temperature-dependent, spectrally integrated line strength \( S(T) \), and the normalized (area=1) shape function \( g(\nu,\nu_0) \), centered at the wavelength \( \nu_0 \).

Standard TDLAS setup
A standard TDLAS setup is illustrated below. It consists of:
- a wavelength tuning DFB laser; emitting monochromatic light at the absorption line of the trace gas
- an optical lens to collimate the laser light
- a gas sample cell; in this case filled with CH₄
- a photo detector on which the laser light is focused; measuring the transmission