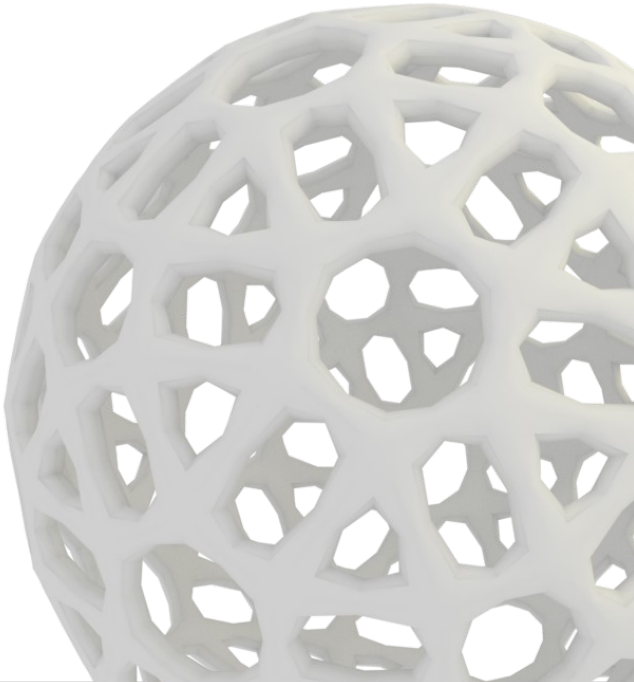
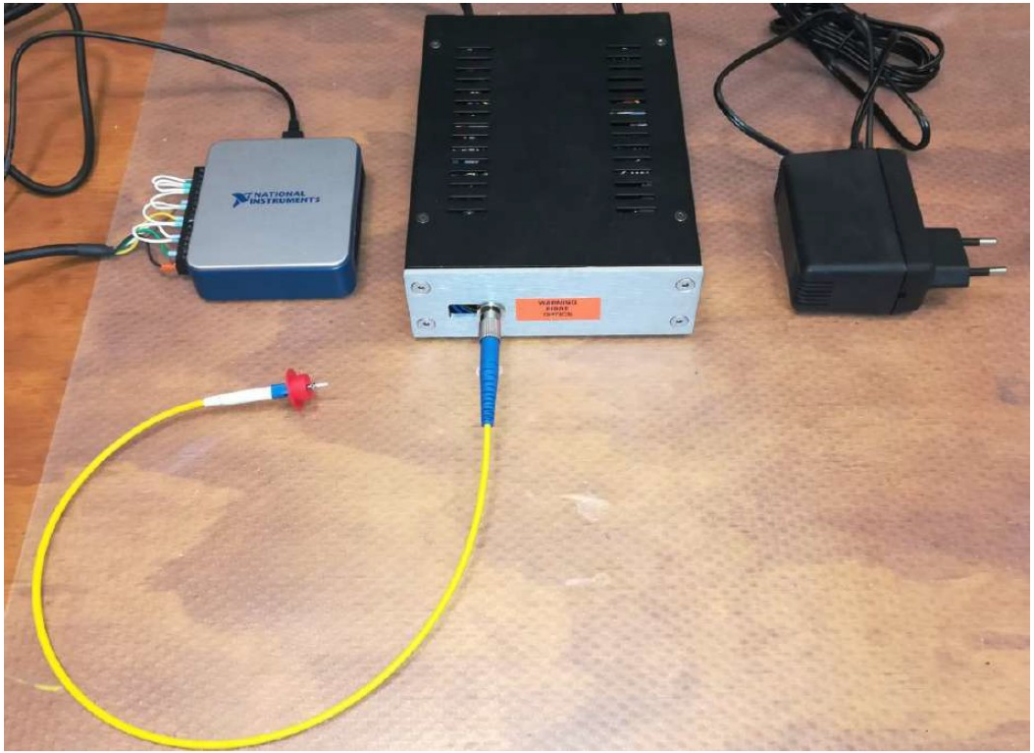
Project TOPDESS

Fiber optic refractometer

System for local concentration measurement



Description and features



Concentration of binary mixtures are measured by means of evaluation of refractive index of the liquid through optical fiber sensor.

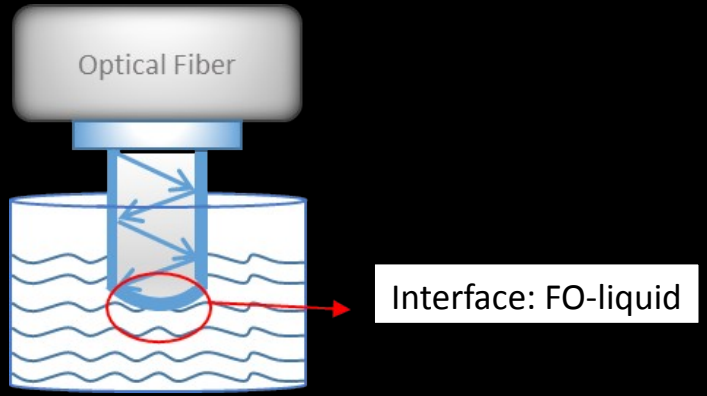
This device is compact (200 mm x 150 mm x 80 mm)

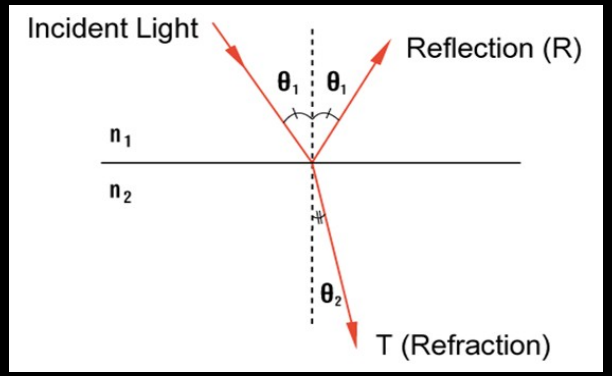
The light which is provided by a laser diode @1550 nm splits with a *"X-split"* junction

(It has two detectors. The first one shows the signal and the second one is the feedback control of the power used for the measurement. The laser light splits 90:10.)

Acquisition and control software are done with user interface (NI and PC card).

Mechanism





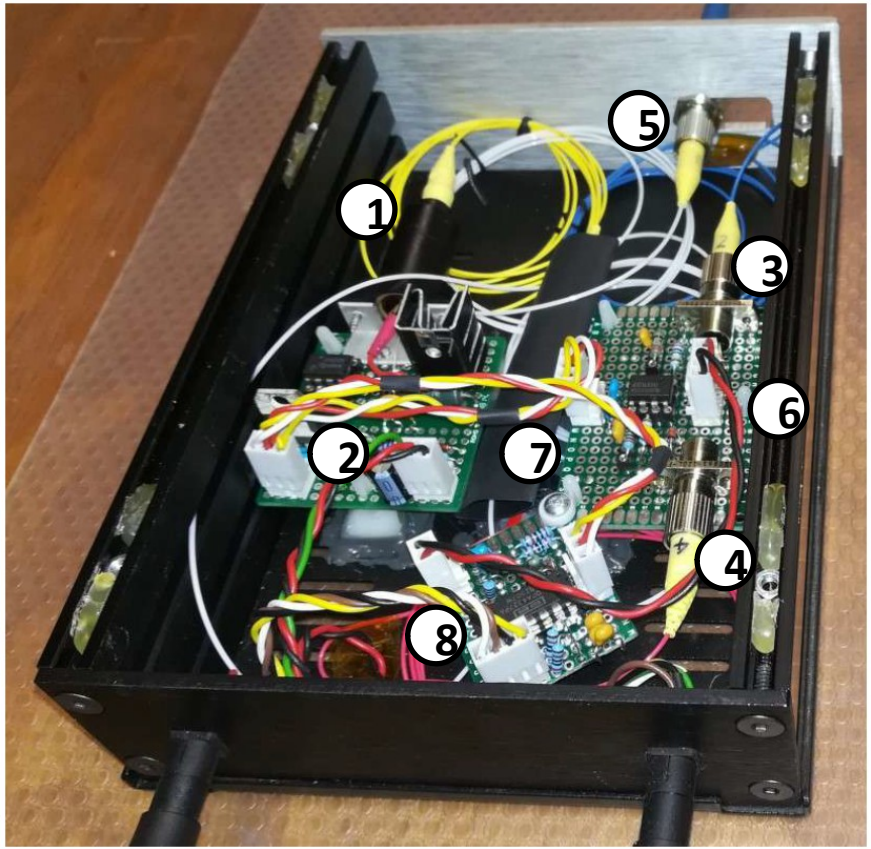
Fiber Optic (FO) refractometer is an optical sensor to measure the real-time refractive index (n) of the liquid based on Fresnel equations of the reflected and transmitted light at the interface between the liquid medium (n_x) and the fiber optic's tip (n_f) which is:

$$\frac{I_R}{I_0} \propto \left(\frac{n_f - n_x}{n_f + n_x}\right)^2$$

Where:

I_R is the reflected light from the sensor
and
I_0 is the laser source signal.

Hardware 1 _ electronics

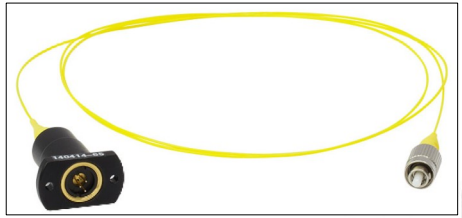


1. Input current (laser)
2. This board is the current generator
3. Detector 2 (reference port-10% arm)
4. Detector 1 (measurement signal port)
5. * Sensor (90% arm)
6. This port is to amplify the diod
7. ** X-splitter
8. This board is the demodulator

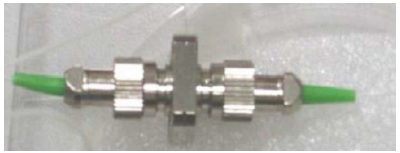
* and ** are shown in more detail in next slides

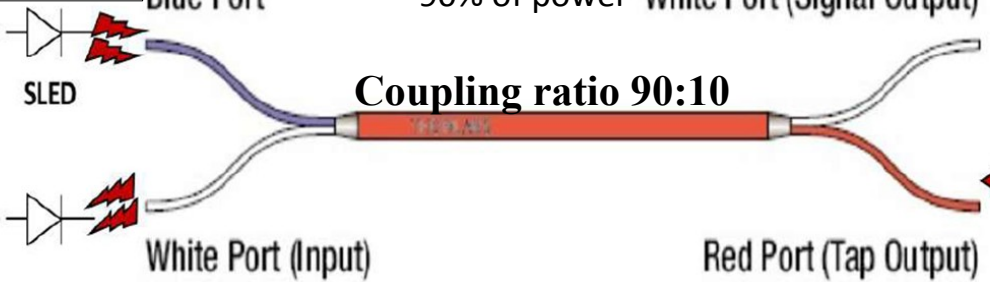
Hardware 2 _ X-split

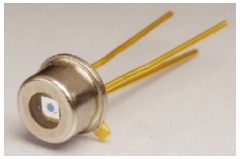
1550 nm, 50 mW, E Pin Code, SM Fiber-Pigtailed Laser Diode, FC/PC



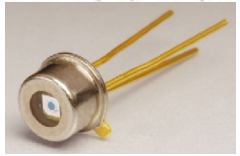
Connectors FC/PC





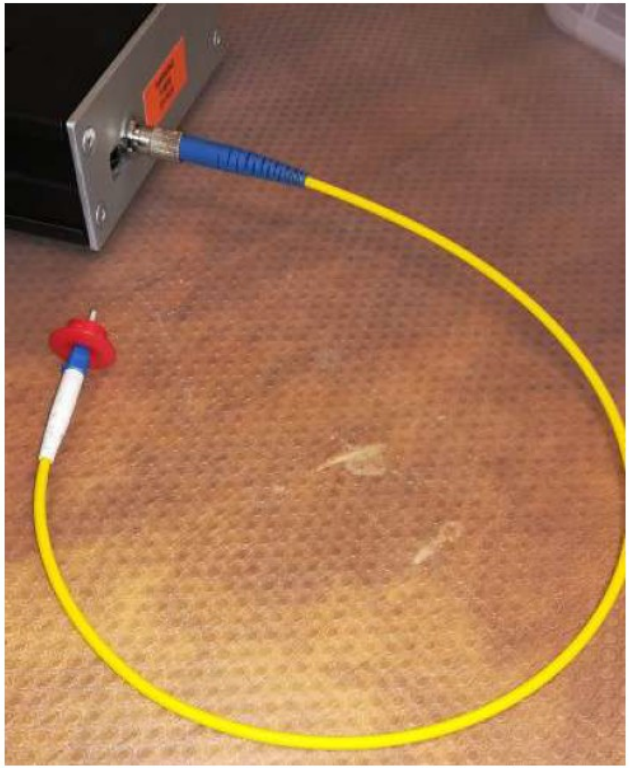


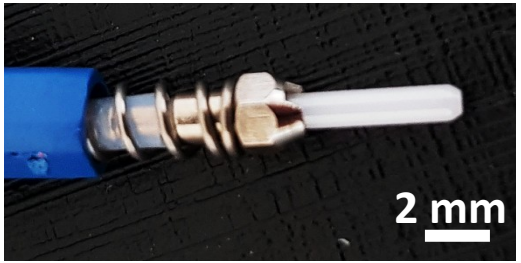
High Speed InGaAs Photodiodes



High Speed InGaAs Photodiodes

Hardware 3 _ fiber optic sensor

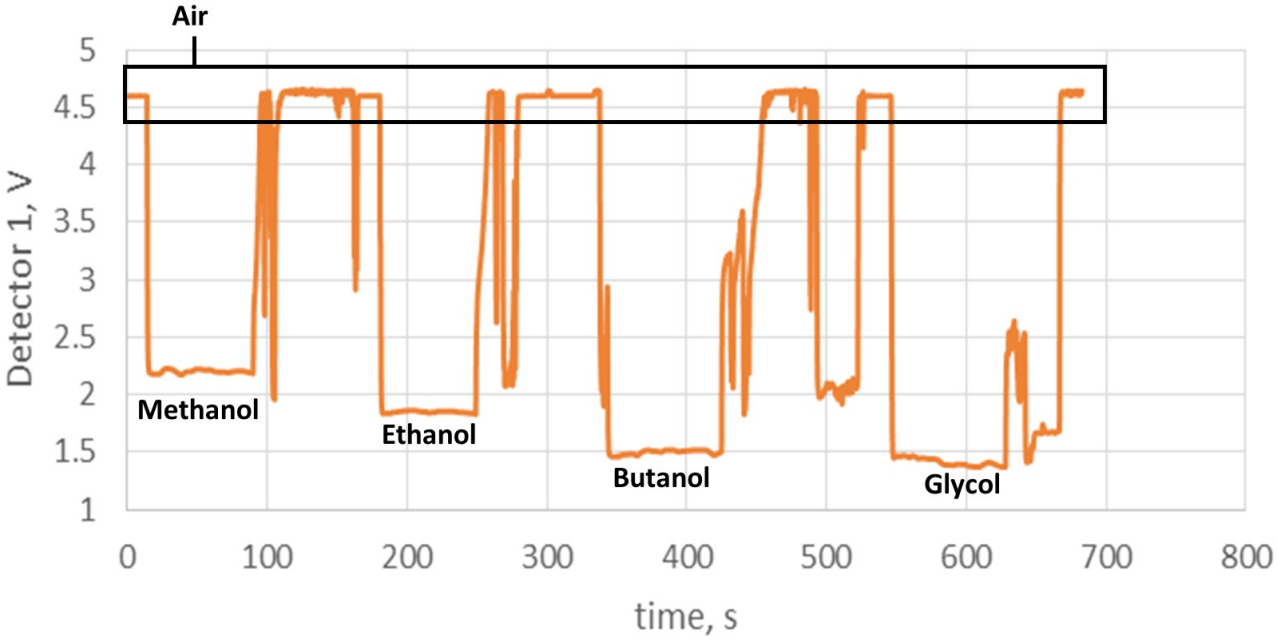




SINGLE-MODE OPTICAL FIBER SPECIFICATION

Optical fiber type	***9/125 OS2 (ITU G.652D)***
Core diameter	9,0 ± 0,4 µm @ 1310 nm 10,1 ± 0,5 µm @ 1550 nm
Cladding diameter	125 ± 0,7 µm
Primary coating diameter	242 ± 7 µm
Cladding Non-Circularity	≤ 0,7%
Concentricity error core/cladding	≤ 0,5 µm
Concentricity error cladding/coating	≤ 12 µm
Attenuation typical/max λ=1310 nm	0,31 – 0,35 dB/Km
Attenuation typical/max λ=1550 nm	0,20 – 0,24 dB/Km
Attenuation typical/max λ=1625 nm	0,21 – 0,26 db/Km
Group Index @ 1310 nm	1,4676
Group Index @ 1550 nm	1,4682
Chromatic @ 1550 nm	≤ 18 ps/(nm·Km)
Chromatic @ 1625 nm	≤ 22 ps/(nm·Km)
Cable cut-off wavelength	$\lambda_{00} \leq 1260$ nm
Zero-dispersion wavelength λ_0	1304 – 1324 nm
Slope at λ_0	$S_0 \leq 0,092$ ps/(nm²·Km)
PMD	≤ 0,1 ps/√Km

Signal measurements



Thanks to the signal acquisition and using the mentioned Fresnel equation it is possible to evaluate the refractive index of the liquid.

Refractive index is a concentration (*C*)- dependent parameter, which means direct and linear relation between *n* and *C* let us measure contribution of each liquid.

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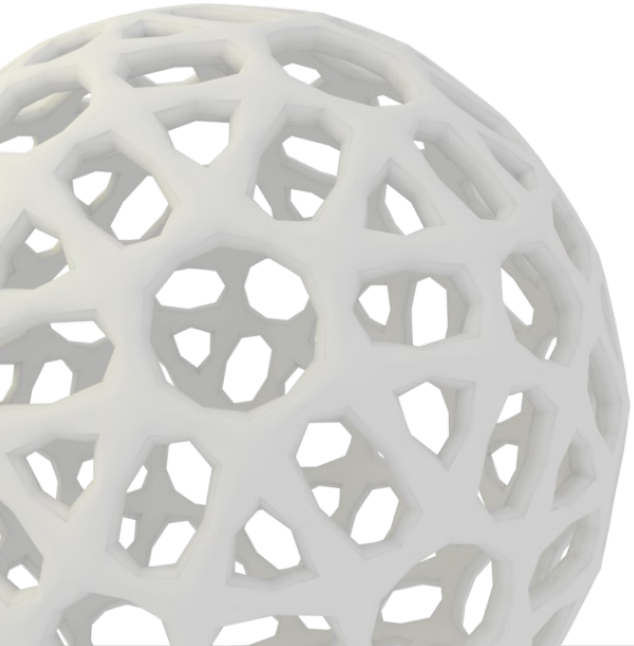

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