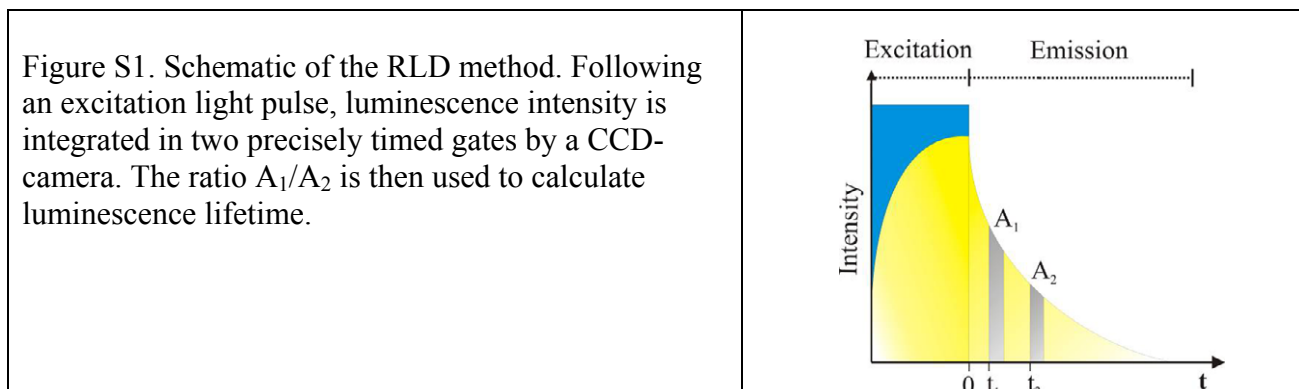# Dual sensing of pO$_2$ and temperature using a water-based and sprayable fluorescent paint

1. The Rapid Lifetime Determination (RLD) Method

A diagram of the RLD method used for determination of the lifetimes is given in Fig. S1.

Figure S1. Schematic of the RLD method. Following an excitation light pulse, luminescence intensity is integrated in two precisely timed gates by a CCD-camera. The ratio A_1/A_2 is then used to calculate luminescence lifetime.

2. Data Evaluation

Under operational conditions the data does of course not coincide with the data points of the calibration. For that purpose the calibration data of the paint were plotted in 3D and fitted with a polynomial surface equation (see Fig. S2). This was done with software called *TableCurve 3D v3.12* according the "Renka II" algorithm [refs. S1 and S2].
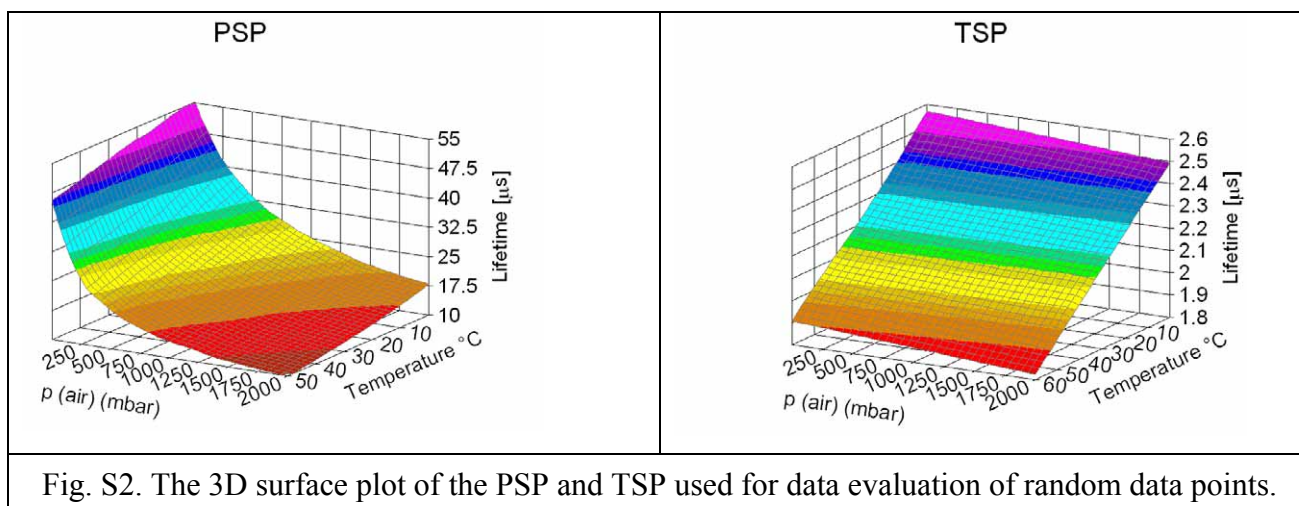

Fig. S2. The 3D surface plot of the PSP and TSP used for data evaluation of random data points.

Specifically, two lifetime values are obtained at any random data point, one for the PSP and one for the TSP. Step one then is to choose a realistic pressure value and calculating the according temperature using the TSP surface plot. In a second step, the PSP lifetime and the temperature value of step 1 are applied to calculate the according pressure with the PSP surface plot. Step one is

repeated with the pressure value calculated in step two. Two iterations usually are adequate to
determine air pressure and temperature with excellent precision. An example:
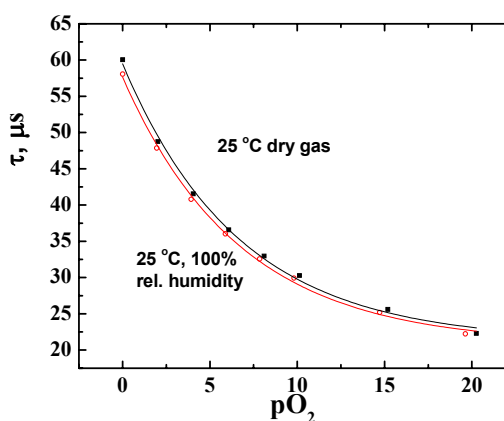
Random lifetime values: TSP = 2.2 µs, PSP = 17.4 µs

Iteration step #	Temperature °C	Air pressure (mbar)	Lifetime (µs)
1 (TSP)	28.8	1000	2.2
2 (PSP)	28.8	1065	17.4
1 (TSP)	28.7	1065	2.2
2 (PSP)	28.7	1068	17.4

3. Effect of Humidity

The luminescence of the paint is barely influenced by the humidity of the gas phase. This was
proven by applying humid gas mixtures that first were humidified by bubbling them through water.
The results were compared with the data obtained with dry mixtures (Fig. S3). The lifetime values
in this experiment were obtained by phase domain spectroscopy and thus slightly deviate from the
values obtained with the RLD method.

Figure S3. The oxygen dependence of the luminescence lifetime of PtTFPP in PS-PVP beads acquired in the frequency domain (modulation frequency f = 5kHz). ~ 100% humidity was achieved by bubbling the gas mixtures through a water bottle.

4. Supporting References:

[S1] R. Renka, *ACM Trans. Math. Software*, **1988,** *14*, 139-148.
[S2] R. Renka, *ACM Trans. Math. Software*, **1988,** *14*, 149-150.