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1. INTRODUCTION

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2. METHODS

A. Experimental Setup

To determine the parameters for the synthetic data for the training of the neural network and for the validation of the method several luminescence measurements were performed under varying conditions.

The sample used for the characterization and test is a commercially available Pt-TFPP-based oxygen sensor spot (PSt3, PreSens Precision Sensing GmbH, Regensburg, Germany). To control the temperature of the samples, these were placed in good thermal contact with a copper plate, placed in a thermally insulated chamber. The temperature of this plate was adjusted at a fixed value between $0\,°C$ and $45\,°C$ using a Peltier element and stabilized with a temperature controller (PTC10, Stanford Research Systems, Sunnyvale, CA USA). The thermally insulated chamber was connected to a self-made gas-mixing apparatus which enabled to vary the oxygen concentration between $0\,\%$ and $20\,\%$ vol O_2 by mixing nitrogen and dry air. In the following, the concentration of oxygen will be given in % of the oxygen concentration of dry air and indicated with % air. This means, for example, that $20\,\%$ air corresponds to $4\,\%$ vol O_2 and $100\,\%$ air corresponds to $20\,\%$ vol O_2. The absolute error on the oxygen concentration adjusted with the gas mixing device is estimated to be below $1\,\%$ air.

The optical setup used in this work for the luminescence measurements is shown schematically in Fig. 1.

The excitation light was provided by a 405 nm LED (VAOL-5EUV0T4, VCC Visual Communications Company, LLC, San Marcos, CA USA), filtered by a an OD5 short pass filter with cut-off at 498 nm (Semrock 498 SP Bright Line HC short pass, Semrock, Inc., Rochester, NY, USA) and focused on the surface of the samples with a collimation lens (EO43987, Edmund Optics, Tucson, AZ USA). The luminescence was focussed by a lens (G063020000, LINOS, Qioptiq, Göttingen, Germany) and collected by a photodiode (SFH 213 Osram, Opto Semiconductors GmbH, Regensburg, Germany). To suppress stray light and light reflected by the sample surface, the emission channel was equipped with an OD5 long pass filter with cut-off at 594 nm (Semrock 594 LP Edge Basic long pass, Semrock, Inc., Rochester, NY, USA) and an OD5 short pass filter with cut-off at 682 nm (Semrock 682 SP Bright Line HC short pass, Semrock, Inc., Rochester, NY, USA). The driver for the LED and the trans-
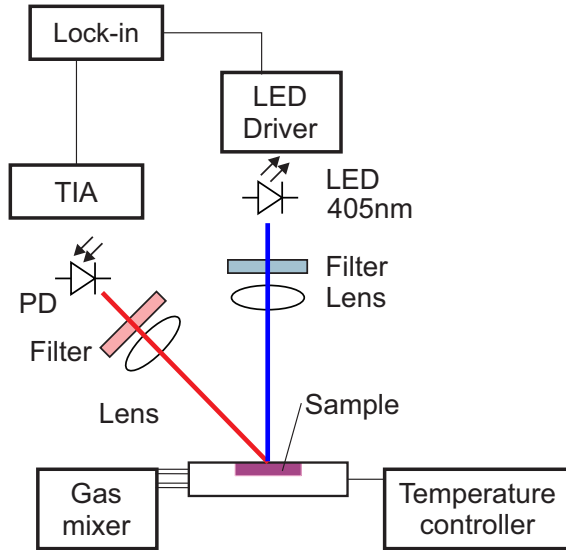
Fig. 1. Scheme of the optical experimental setup. Blue is the excitation, red the luminescence optical path. PD: photodiode; TIA: trans-impedance amplifier.

impedance amplifier (TIA) are self-made. For the frequency generation and the phase detection a two-phase lock-in amplifier (SR830, Stanford Research Inc.) was used. The modulation frequency was varied between 200 Hz and 20 kHz.

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B. Artificial Neural Network Setup

3. RESULTS AND DISCUSSION

A. Sample Table

Table 1 shows an example table.

Table 1. Shape Functions for Quadratic Line Elements

local node	$\{N\}_m$	$\{\Phi_i\}_m \ (i = x, y, z)$
$m = 1$	$L_1(2L_1 - 1)$	Φ_{i1}
$m = 2$	$L_2(2L_2 - 1)$	Φ_{i2}
$m = 3$	$L_3 = 4L_1L_2$	Φ_{i3}

4. CONCLUSIONS

DISCLOSURES

Disclosures. The authors declare no conflicts of interest.

SUPPLEMENTAL DOCUMENTS

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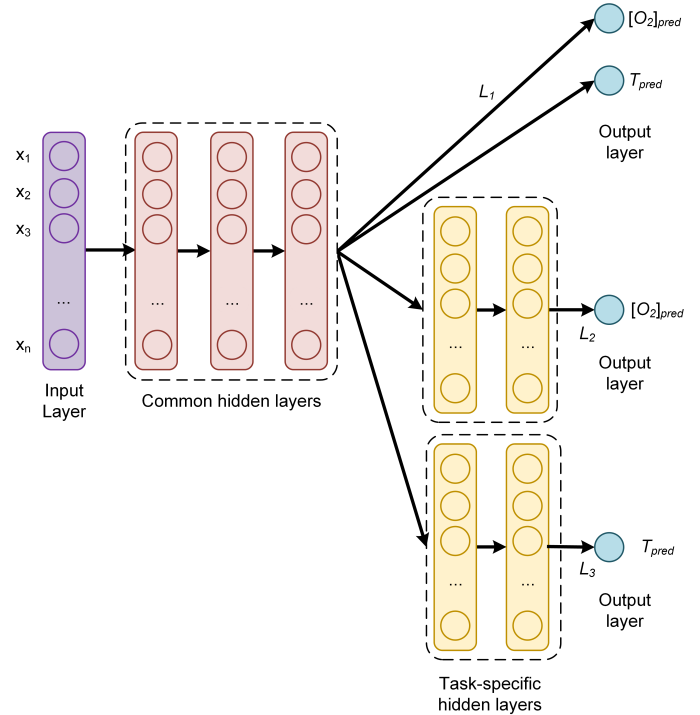

Fig. 2. Architecture of the feed-forward MTL.

REFERENCES

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