Magnetic Optical Sensor Particles: A Flexible Analytical Tool for Microfluidics

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Supporting information

Fig. 1 Separation behavior of different particle sizes from a MOSeP dispersion. The graph illustrates observed signal intensities of MOSePs of varying particle diameters.

Fig. 2 Calibration plots for MOSePs applying four different oxygen sensing systems for oxygen monitoring from 0-100% air saturation: (●) PtTpPFTBP (fiber optic read-out), (Δ) Ir(C₆)₂(acac) (lifetime imaging) (○) PtTFPP and MY (lifetime imaging) and (▼) PtTFPP and MY (RGB imaging). The error bars show experimental data from 3 subsequent measurements.

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Table 1 Calibration data of luminescent magnetic nano sensor particles for fiber optic read-out and imaging applications for oxygen monitoring from 0-100% air saturation.

<table>
<thead>
<tr>
<th>read-out</th>
<th>sensor dye ([%(w/w)])</th>
<th>$t_0$/$t_1$</th>
<th>$R_{0}/R_{avr}$</th>
<th>$K_{av}$ [hPa$^{-1}$]</th>
<th>$t_f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>fiber optic</td>
<td>PtPFPtBP (0.5)</td>
<td>3.17 ± 0.01</td>
<td>0.01408 ± 0.00018</td>
<td>0.916 ± 0.003</td>
<td></td>
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<tr>
<td>lifetime imaging</td>
<td>Ir(C$_5$H$_4$) (1.5)</td>
<td>1.75 ± 0.01</td>
<td>0.00486 ± 0.00002</td>
<td>0.847 ± 0.002</td>
<td></td>
</tr>
<tr>
<td>lifetime imaging</td>
<td>PtTFPP (1.5) and MY (3)</td>
<td>2.66 ± 0.01</td>
<td>0.01506 ± 0.00037</td>
<td>0.824 ± 0.006</td>
<td></td>
</tr>
<tr>
<td>RGB imaging</td>
<td>PtTFPP (1.5) and MY (3)</td>
<td>2.08 ± 0.01</td>
<td>0.00769 ± 0.00015</td>
<td>0.842 ± 0.008</td>
<td></td>
</tr>
</tbody>
</table>

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Computational Fluid Dynamics simulation studies using ANSYS CFX® software and Solid works revealed that the formed sensing spots do not cause turbulences. Figure 3 shows the velocity profile inside a microchannel with integrated magnetic sensor spots (d = 2 mm) for sensor spot heights of (A) 10 µm (realistic dimension) and (B) 200 µm (for comparison). A sensing spot with 10 µm spot height exhibited homogeneous velocity profiles across the whole microfluidic channel length and width with minimal variations of flow velocity. Computational Fluid Dynamics simulation studies showed that the flow runs around the sensor spot smoothly even for sensor spots with 200 µm height, although the simulation revealed inhomogenous velocity profiles across the microfluidic channel length and width.

![Simulation results for flow and velocity profiles in microfluidic channels](image)

**Fig. 3** Simulation results for flow and velocity profiles in microfluidic channels (height = 300 µm, width = 3 mm) at a fluid flow of 1 mL·min$^{-1}$ with integrated magnetic sensor spots (d = 2 mm) for sensor spot heights of (A) 10 µm and (B) 200 µm.

References