The Interplay of Indicator, Support and Analyte in Optical Sensor Layers

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Abstract It has been recognized since the pioneering times of fiber-optic sensing development that the best indicator dye is worth nothing without a (polymer) support fitted
to both the determinand species and the indicator itself. However, the task of selecting an organic or inorganic polymer for manufacturing a sensitive head among the myriad of materials available nowadays may seem daunting to the researcher or technologist. Moreover, if we also incorporate a biological recognition element to develop an ultrasensitive or specific biosensor, the multifaceted problem appears even more puzzling. This chapters aims to guide the reader through the current world of both organic and inorganic materials and their effect on (bio)chemical sensing. Selected examples illustrate the diversity of solid supports and composites and their effect on the indicator response, photostability, interaction with the analyte, stability of the different biological elements, and ease of preparation, among other factors, shedding some light on the complex interaction between the key components of chemical sensors and biosensors.

**Keywords** Biosensors · Dyes · Fluorescence · Glass · Immunosensors · Luminescence · Nanocomposites · Optodes · Optosensors · Ormosils · PVC · Silica · Siloxanes · Sol-gel

**Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BNHS</td>
<td>biotinyl N-Hydroxysuccinimide ester</td>
</tr>
<tr>
<td>CCD</td>
<td>Charge-coupled device</td>
</tr>
<tr>
<td>CPG</td>
<td>Controlled-pore glass</td>
</tr>
<tr>
<td>$D$</td>
<td>Diffusion coefficient</td>
</tr>
<tr>
<td>DMMP</td>
<td>Dimethyl methylphosphonate</td>
</tr>
<tr>
<td>DPO</td>
<td>4-(p-N,N-Dimethylaminophenylmethylene)-2-phenyl-5-oxazolone</td>
</tr>
<tr>
<td>dppz</td>
<td>Dipyrido[3,2-a:2′,3′-c]phenazine</td>
</tr>
<tr>
<td>ELBL</td>
<td>Electrostatic layer-by-layer assembly</td>
</tr>
<tr>
<td>FRET</td>
<td>Fluorescence resonance energy transfer</td>
</tr>
<tr>
<td>GMBS</td>
<td>N-Succinimidyl 4-maleimidobutyrate</td>
</tr>
<tr>
<td>$I$</td>
<td>Luminescence intensity</td>
</tr>
<tr>
<td>ISO</td>
<td>Ion-selective optode</td>
</tr>
<tr>
<td>$K_d$</td>
<td>Dissociation constant</td>
</tr>
<tr>
<td>$k_q$</td>
<td>Quenching rate constant</td>
</tr>
<tr>
<td>$K_{SV}$</td>
<td>Stern–Volmer constant</td>
</tr>
<tr>
<td>MB</td>
<td>Methylene blue</td>
</tr>
<tr>
<td>MBe</td>
<td>Molecular beacon</td>
</tr>
<tr>
<td>NR</td>
<td>Nile Red</td>
</tr>
<tr>
<td>ormosils</td>
<td>Organically-modified silicates</td>
</tr>
<tr>
<td>ormosers</td>
<td>Organically-modified ceramics</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic aromatic hydrocarbons</td>
</tr>
<tr>
<td>PAMAM</td>
<td>Polyamidoamine</td>
</tr>
<tr>
<td>PEBBLE</td>
<td>Probes encapsulated by biologically localized embedding</td>
</tr>
<tr>
<td>phen</td>
<td>1,10-Phenanthroline</td>
</tr>
<tr>
<td>PrA</td>
<td>Protein A</td>
</tr>
<tr>
<td>PrG</td>
<td>Protein G</td>
</tr>
<tr>
<td>PV</td>
<td>Pyrocatechol Violet</td>
</tr>
<tr>
<td>PVC</td>
<td>Poly(vinyl chloride)</td>
</tr>
<tr>
<td>RB3(^{2+})</td>
<td>Tris(2,2′-bipyridine)ruthenium(II) cation</td>
</tr>
<tr>
<td>RDP3(^{2+})</td>
<td>Tris(4,7-diphenyl-1,10-phenanthroline)ruthenium(II) cation</td>
</tr>
<tr>
<td>RTP</td>
<td>Room temperature phosphorescence</td>
</tr>
<tr>
<td>S</td>
<td>Solubility</td>
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<tr>
<td>SPR</td>
<td>Surface plasmon resonance</td>
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