3D Bismuth ferrite Nanoflowers Electrochemical sensor for the multiple detection of pesticides

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Introduction

- Imidacloprid (IMD) and Fipronil (FIP) are currently dominating the world insecticide market due to their selective toxicity on their target invertebrates
- They act on the Central Nervous System leading to the death of their target invertebrate
- Their presence in environment has increased due to their extensive usage
- This work presents an electrochemical sensor for the determination of IMD and FIP using a carbon paste electrode (CPE) modified with bismuth ferrite nanoflowers (BiFeO₃/CPE)

Experimental

Bi(NO₃)₃·5H₂O Fe(NO₃)₃·9H₂O

Hydrothermal conditions 160 °C, 14 hrs

BiFeO₃ nanoparticles

Graphite powder

Mineral oil

Characterization of the nanoflowers

The SEM micrograph shows that the average size of the nanoflowers is approximately 10 µm. The nanoflowers are not perfectly spherical, and a sort of hollows where the petals are packed less dense present

The TEM image reveals a uniformly shaped nanoparticle. A diameter of a spherical BiFeO₃ particle was measured to be about 25-35 nm

Results and Discussion

Table 1 IMD and FIP determination in real samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Added (µM) IMD</th>
<th>Found (µM) IMD</th>
<th>Found (µM) FIP</th>
<th>IMD recovery (%)</th>
<th>FIP recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water</td>
<td>10.0</td>
<td>9.0</td>
<td>9.5</td>
<td>90.0%</td>
<td>105.0%</td>
</tr>
<tr>
<td>Lake water</td>
<td>15.0</td>
<td>14.5</td>
<td>14.0</td>
<td>96.7%</td>
<td>94.5%</td>
</tr>
<tr>
<td>Irrigation water</td>
<td>20.0</td>
<td>18.0</td>
<td>17.0</td>
<td>90.9%</td>
<td>90.0%</td>
</tr>
<tr>
<td>Irrigation water</td>
<td>30.0</td>
<td>28.0</td>
<td>27.0</td>
<td>93.3%</td>
<td>103.4%</td>
</tr>
</tbody>
</table>

Conclusions

1. The synthesized nanoparticles increased the value of the current by almost 100%
2. The samples can be used directly without filtration or dilution
3. The shape and structure of the particles were confirmed by XRD, FT-IR, SEM and TEM.
4. The analytical utility of the proposed sensor was tested using environmental water samples collected from Egypt