Novel electrochemical sensor for the multiple detection of pesticides using bismuth ferrite nanoflowers

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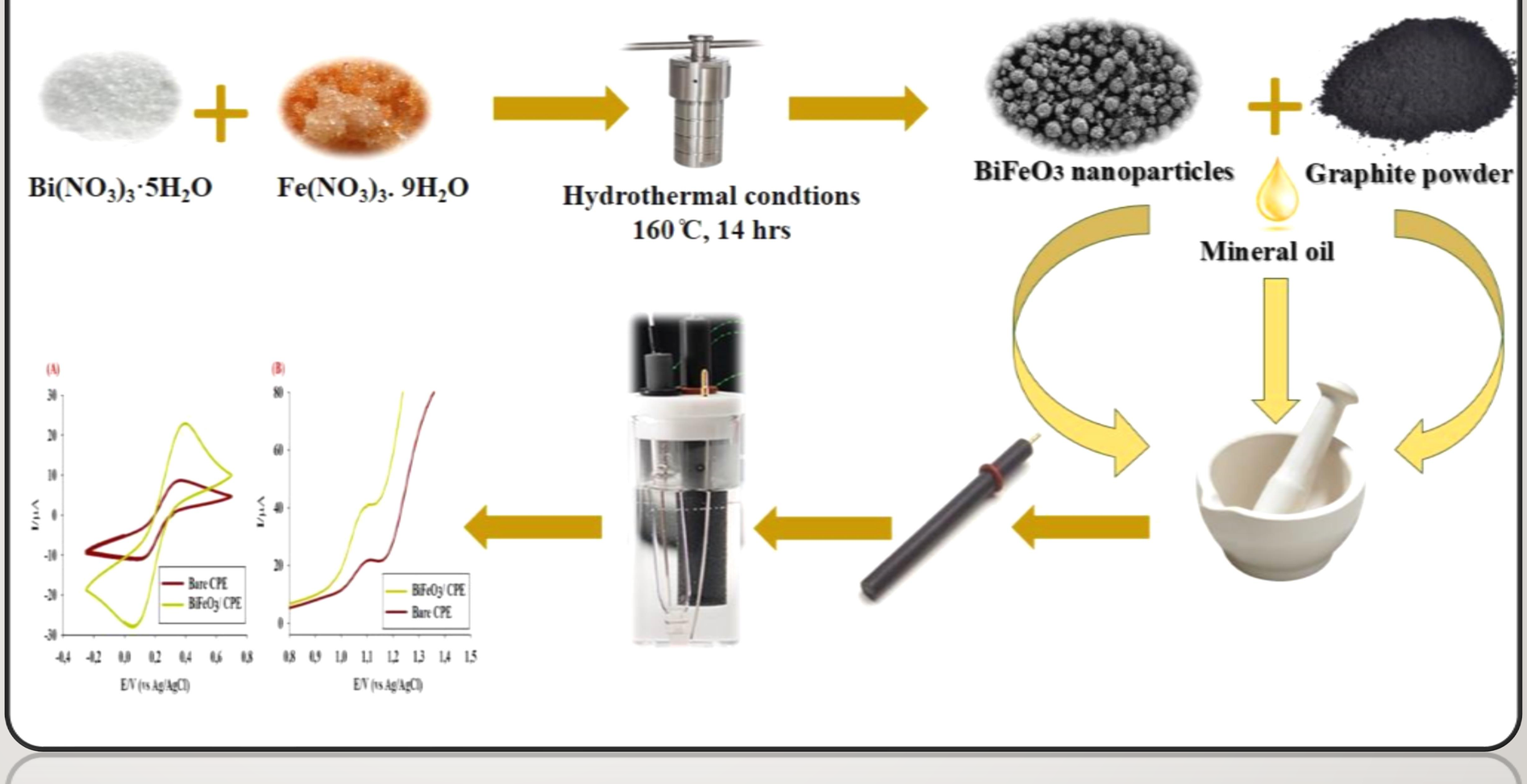
Introduction

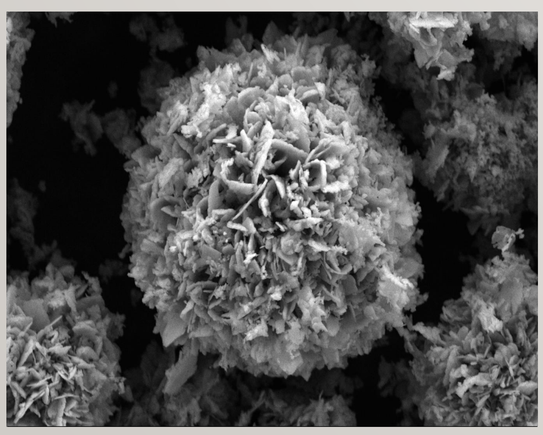
- **Imidacloprid (IMD) and Fipronil (FIP) are currently dominating the world insecticide market due to their selective toxicity on their target invertebrates.**
- **They act on the Central Nervous System leading to the death of their target invertebrate.**
- **Their presence in environment has increased 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 ($BiFeO_3$/CPE)**

Materials and Methods

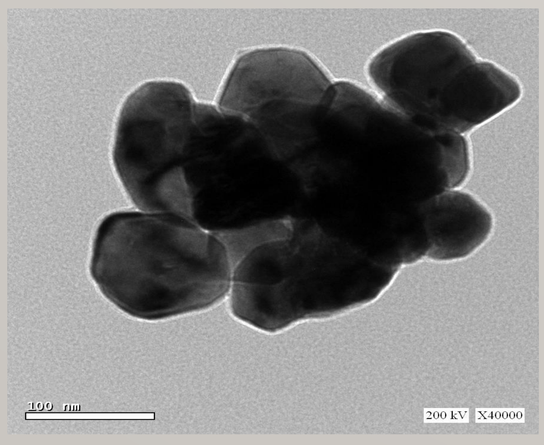


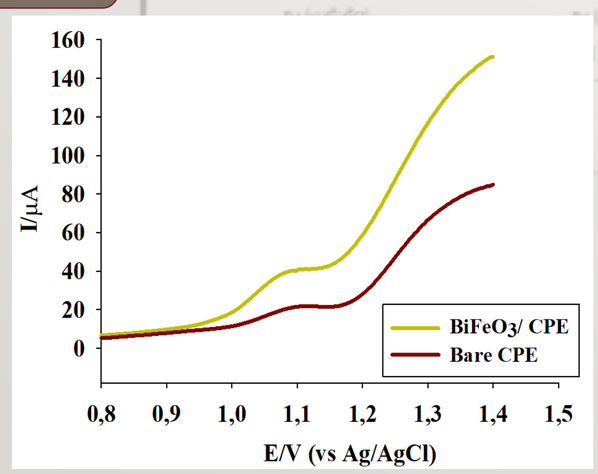
Results and Discussion

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

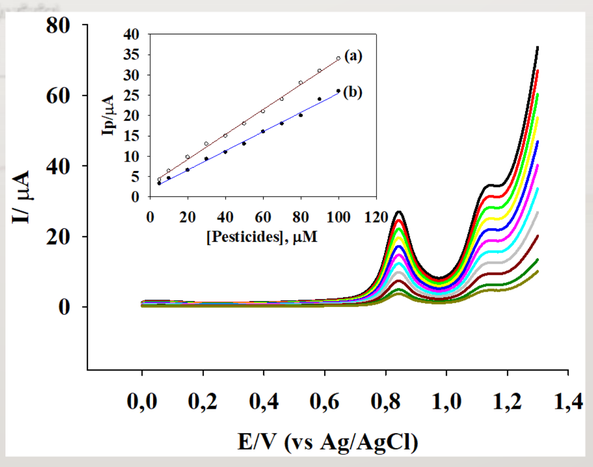




Square wave voltammograms obtained for 1.0×10^{-3} mol L^{-1} IMD on CPE and $BiFeO_3$ /CPE at 100 mV s^{-1} in Britton-Robinson buffer (pH= 10.0)

The value of the anodic peak current for the bare CPE and for the $BiFeO_3$ /CPE were 20 µA and 38 µA, respectively (Figure 2C). There was an increase for almost 100% due to the modification.

The TEM image reveals a uniformly shaped nanoparticle. A diameter of a spherical $BiFeO_3$ particle was measured to be about 25-35 nm



Square wave voltammograms **obtained at the surface of the $BiFeO_3$/CPE in 0.1 M Britton-Robinson buffer (pH 10.0) containing different concentrations of IMD and FIP. Insert: (a) plots of Ip vs. IMD concentrations in the range of 1.0 – 100.0 µM and (b) plot of Ip vs. FIP concentrations in the range of 1.0 – 100.0 µM**

.This figure shows the oxidation of both IMD and FIP on the same $BiFeO_3$/ CPE electrode at different concentrations. This shows the possibility of detecting both IMD and FIP in the same sample

The LODs were calculated for IMD and FIP to be **0.97 µM** and **1.27 µM**, respectively. In Table 1, different methodologies for IMD determination reported in literature are shown with LODs between 0.012 nM and 8.92 µM. **This indicates that our methodology presents an acceptable detection limit.**

To test the applicability of the developed sensor for IMD determination in the presence of FIP samples, tap, river and irrigation water samples were freshly collected from Al-Fayoum Governorate in Egypt. Those samples were spiked with two different concentrations of IMD-FIP mixture with no pretreatment step, and the results are shown in Table 1. The recovery percentages varied between **90.0%** and **105.0 %**. which is excellent for usage in environmental analysis.

Table 1 IMD and FIP determination in real samples

Sample	Added (µM) IMD-FIP	Found (µM) IMD	Found (µM) FIP	Recovery (%) IMD	Recovery (%) FIP
Tap water	10.0	9.0	10.5	90.0 %	105.0%
Tap water	15.0	14.5	14.0	96.7%	93.4%
River water	20.0	21.0	18.0	105.0%	90.0%
River water	30.0	28.0	31.0	93.3%	103.4%
Irrigation water	40.0	41.0	37.0	102.5%	92.5%
Irrigation water	50.0	52.0	49.5	104.0%	99.0%

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**

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