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Tailoring Polythiophene Nanocomposites with MnS/CoS Nanoparticles for Enhanced Surface-Enhanced Raman Spectroscopy (SERS) Detection of Mercury Ions in Water

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Abstract : The excessive emission of heavy metal ions from industrial processes poses a serious threat to both the environment and human health. This study presents a distinct approach utilizing (PTh-MnS/CoS NPs) for the highly selective and sensitive detection of Hg^{2+} ions in water. Such detection is crucial for safeguarding human health, protecting the environment, and accurately assessing toxicity. The fabrication method employs a simple and efficient chemical precipitation technique, harmoniously combining polythiophene, MnS, and CoS NPs to create highly active substrates for SERS. The MnS@Hg^{2+} exhibits a distinct Raman shift at 1666 cm^{-1}, enabling specific identification and demonstrating the highest responsiveness among the studied semiconductor substrates with a detection limit of only 1 nM. This investigation demonstrates reliable and practical SERS detection for Hg^{2+} ions. Relative standard deviation (RSD) ranged from 0.49% to 9.8%, and recovery rates varied from 96% to 102%, indicating selective adsorption of Hg^{2+} ions on the synthesized substrate. Furthermore, this research led to the development of a remarkable set of substrates, including (MnS, CoS, MnS/CoS, and PTh-MnS/CoS) nanoparticles were created right there on SiO_2/Si substrate, all exhibiting sensitive, robust, and selective SERS for Hg^{2+} ion detection. These platforms effectively monitor Hg^{2+} concentrations in real environmental samples.

Keywords : surface-enhanced raman spectroscopy (SERS), sensor, mercury ions, nanoparticles, and polythiophene.
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