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Facile Synthesis of Neodymium Stannate Nanoparticles an Effective Electrocatalyst for the Selective Detection of Dimetridazole in Biological Samples

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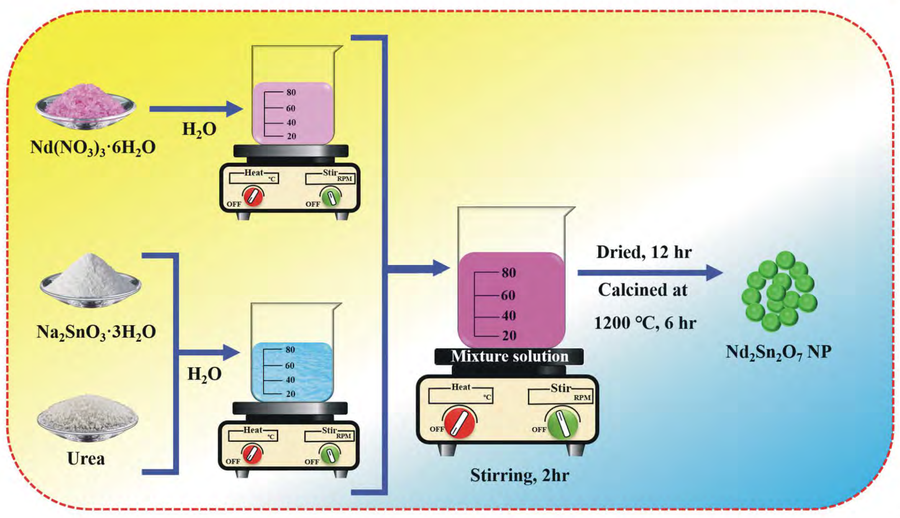
Abstract

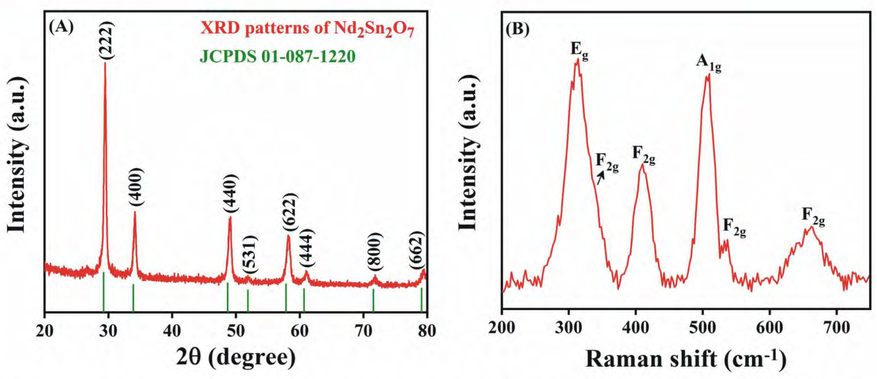
- In this work, pyrochlore neodymium stannate nanoparticles ($Nd_2Sn_2O_7$ NP) have been synthesized by a facile co-precipitation technique and employed as an electrode material on GCE for the determination of dimetridazole (DM) drug.
- The fabricated $Nd_2Sn_2O_7$ NP/GCE shows a lower LOD of 6 nm towards the determination of DM and the calculated sensitivity is 0.61 μA μM^{-1} cm^{-2}.
- In addition to that, the constructed sensor delivers notable repeatability, reproducibility, and superior selectivity.
- Furthermore, $Nd_2Sn_2O_7$ NP/GCE sensor displays acceptable recovery results in the real sample analysis in biological samples.

Synthesis Procedure



Scheme 1. The coprecipitation synthesis of $Nd_2Sn_2O_7$ NP.

Results and Discussion



Scheme 1. Fig. 1. (A, B) XRD patterns, and Raman spectra of $Nd_2Sn_2O_7$.

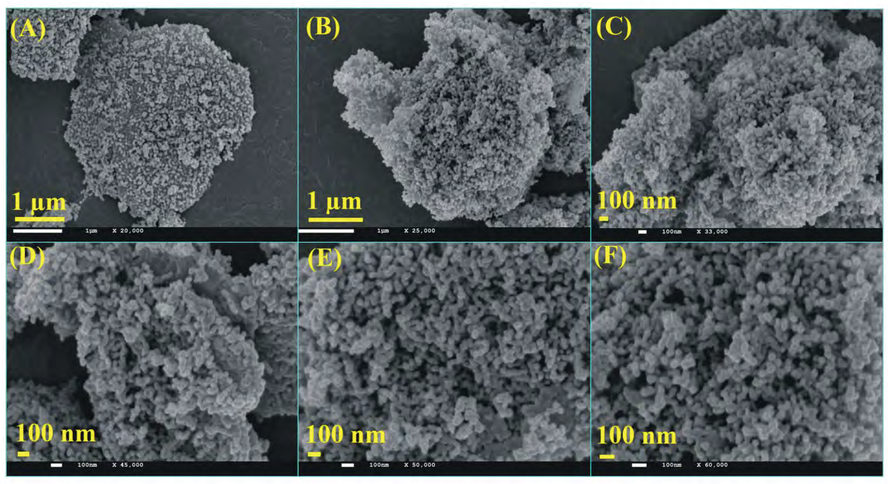


Fig. 2. (A-B) low and (C-F) high magnification FE-SEM images of $Nd_2Sn_2O_7$ NP.

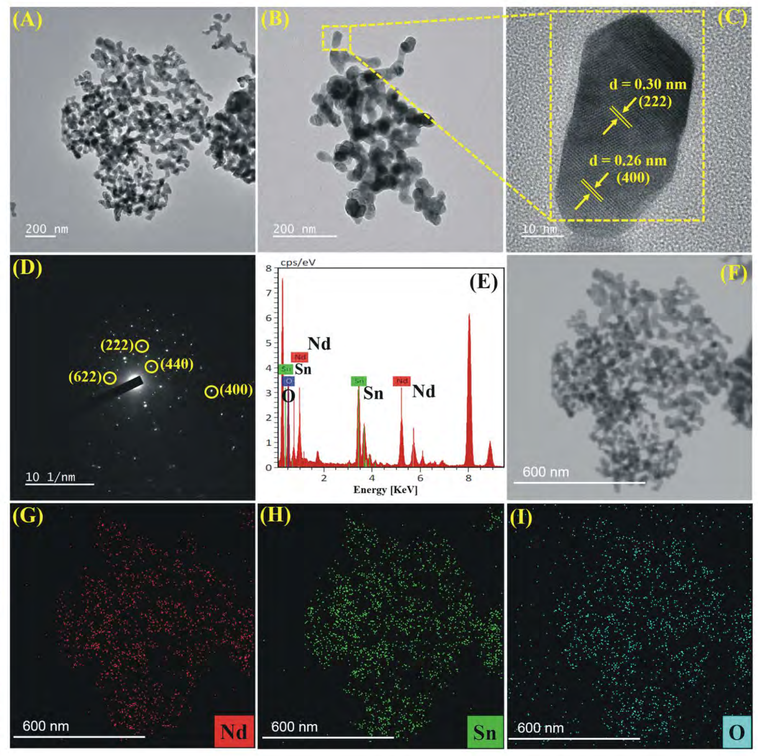


Fig. 3. (A, B) The low-magnification HR-TEM images of $Nd_2Sn_2O_7$. (C) The lattice fringes, (D) SAED patterns, (E) EDX spectrum of $Nd_2Sn_2O_7$ NP. (F) The HR-TEM electron image and (G-I) the corresponding elemental mapping images showing the distribution of elements, namely (G) Neodymium (Nd), (H) Tin (Sn) and (I) Oxygen (O).

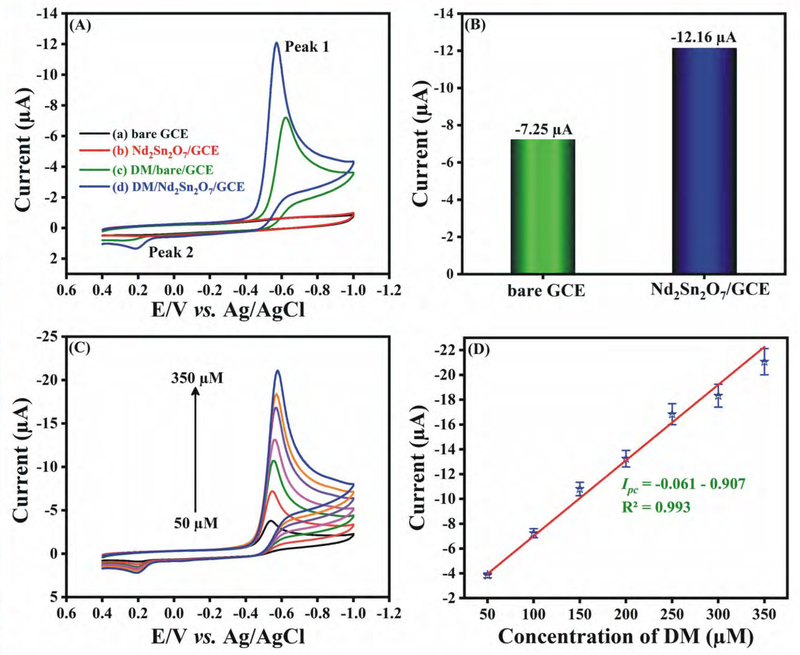


Fig. 5. (A) CV curves of (a) blank GCE, (b) $Nd_2Sn_2O_7$/GCE in the absence of DM; (c) DM/bare/GCE, (d) DM/$Nd_2Sn_2O_7$/GCE in the presence of 150 μM of DM. (B) Bar diagram; Recorded cathodic current response of 150 μM on bare GCE and $Nd_2Sn_2O_7$/GCE. (C) The obtained CV signals for different concentrations of DM (50 to 350 μM) on $Nd_2Sn_2O_7$/GCE. (D) The linear plot: Concentration of DM (μM) vs. cathodic current (*Ipc*). All experiments were performed at 50 mV/s (Electrolyte: 0.05 M PB solution (pH 7.0)).

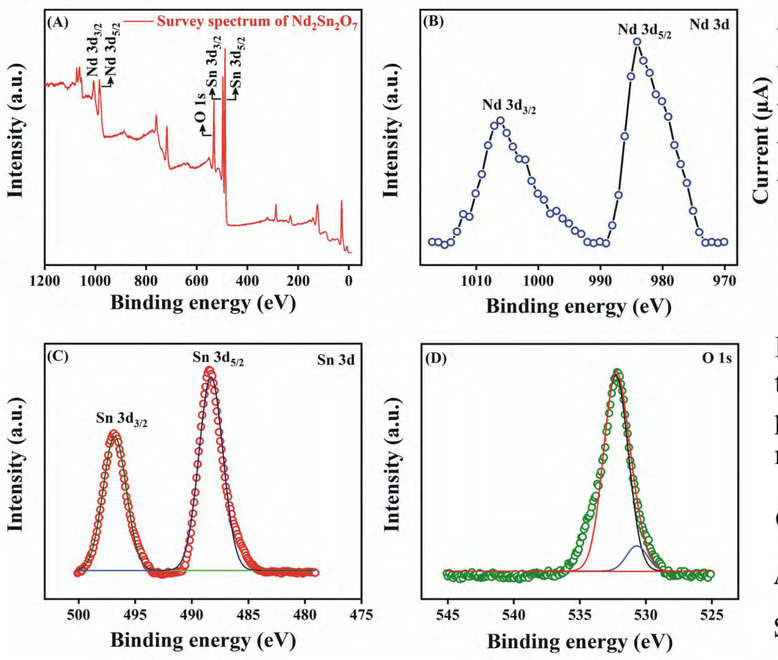
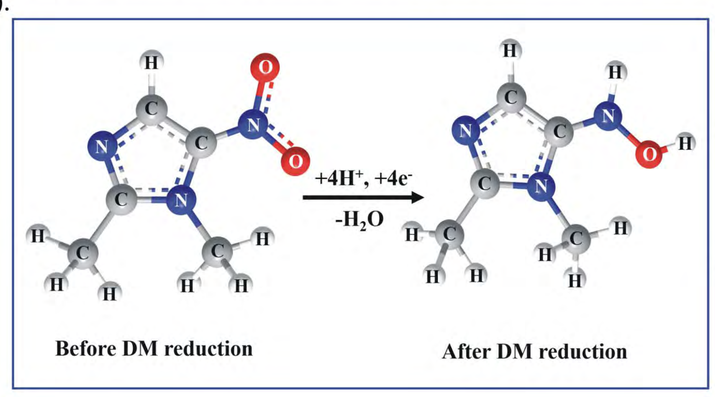


Fig. 4. (A) The overall XPS survey spectrum of $Nd_2Sn_2O_7$ NP. The core-level XPS spectra of Nd 3d (B), Sn 3d (C), and O 1s (D).



Scheme 2. The electrocatalytic reduction mechanism of DM at $Nd_2Sn_2O_7$ modified GCE.

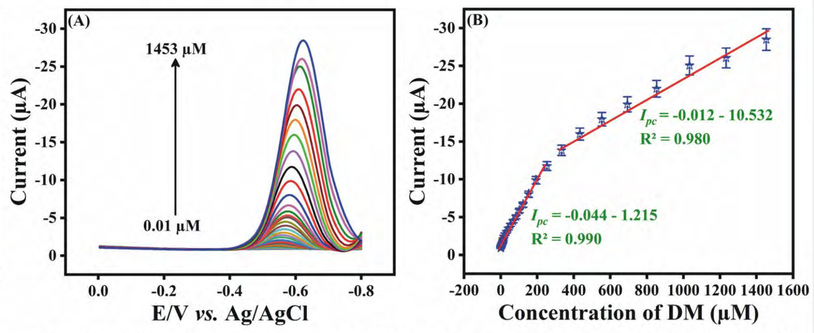


Fig. 6. (A) DPV curves of different concentrations of DM (0.01 to 1453 μM) in 0.05 M PB solution. (B) The linear calibration plot between the concentrations of DM vs. cathodic current response.

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Conclusion

- In conclusion, we have successfully synthesized a cubic pyrochlore $Nd_2Sn_2O_7$ NP using a low-cost co-precipitation synthesis method.
- The constructed $Nd_2Sn_2O_7$/GCE shows magnificent electrocatalytic performance towards the determination of veterinary and antibacterial drug DM with a lower LOD of 6 nm.
- From the observed results and electrochemical findings, we believe that the as-prepared highly crystalline cubic pyrochlore $Nd_2Sn_2O_7$ NP/GCE will be implemented to a promising electrochemical sensor for the determination of DM along with the real-sample analyses in biological fluids.