

Abstract:

This study reports a novel electrochemical sensing platform based on chitosan-functionalized MWCNTs and nickel-doped bismuth sulphide modified screen-printed electrodes for the simultaneous real-time detection of 4-ASA and 5-ASA in urine. The sensor demonstrated low detection limits, high sensitivity, excellent recovery rates in real samples, and successful integration into a handheld device, highlighting its strong potential for point-of-care therapeutic monitoring.

Background

Why 4-ASA & 5-ASA?

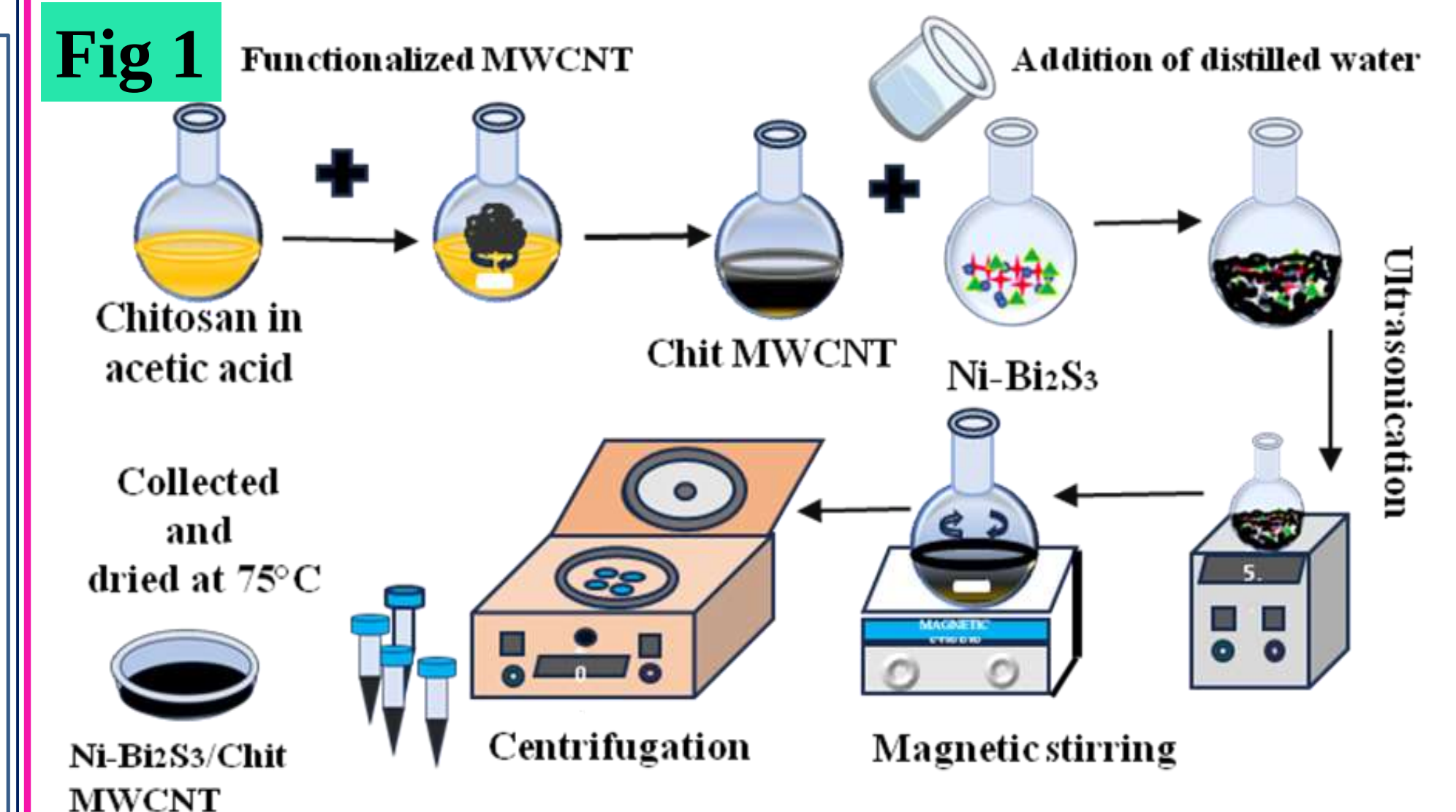


5-ASA (Mesalamine) is a frontline drug for treating inflammatory bowel diseases (IBDs) such as ulcerative colitis and Crohn's disease. However, prolonged and high-dose usage may lead to toxicity and adverse side effects.

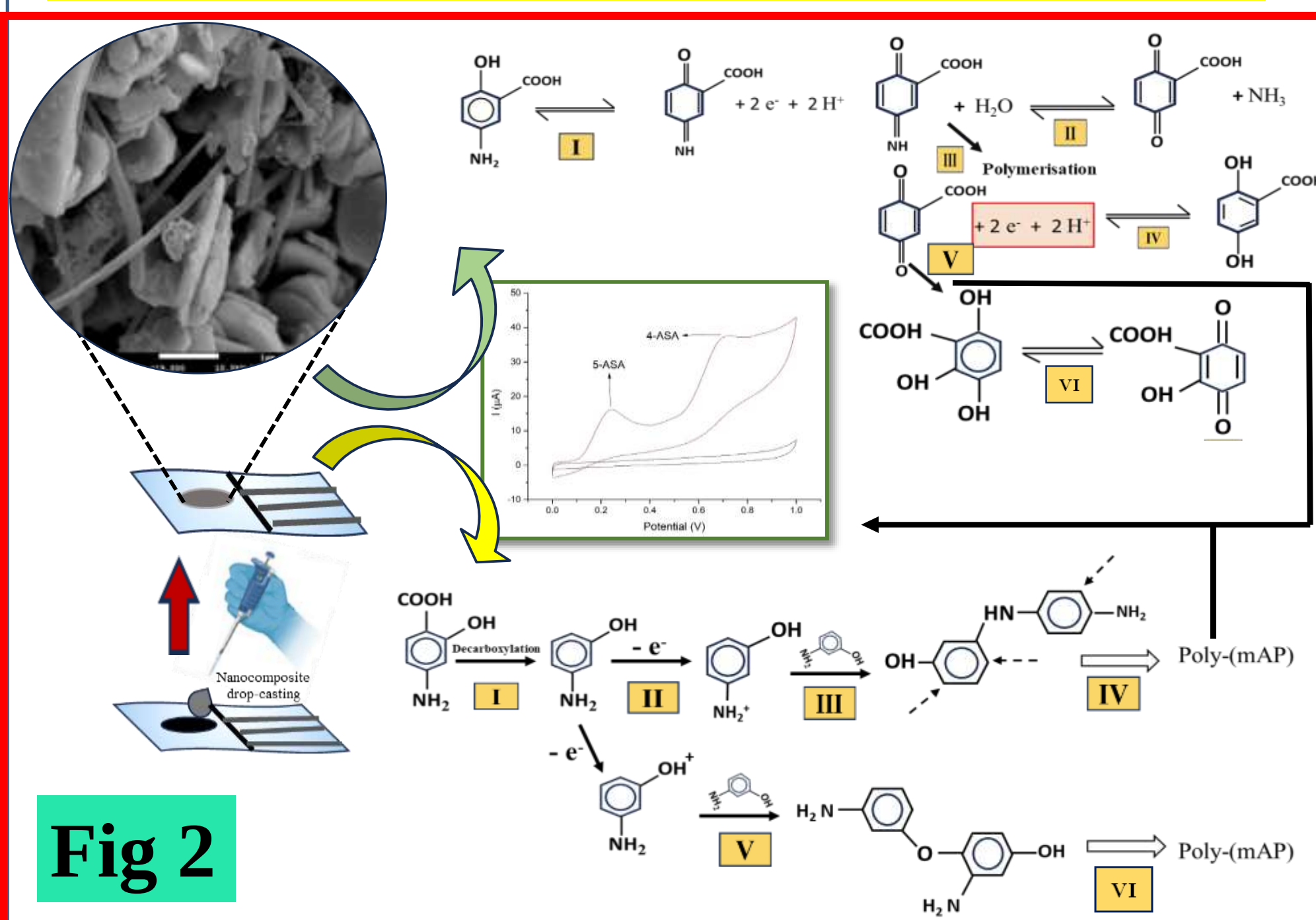
4-ASA, the positional isomer of 5-ASA, exhibits nearly 50% greater anti-inflammatory potency, improved bioavailability, lower therapeutic dosage requirements, and reduced immune-allergic side effects.

As 4-ASA-based prodrugs are increasingly being combined with 5-ASA therapies as part of a comprehensive IBD treatment strategy, simultaneous monitoring of both drugs becomes crucial for effective therapeutic management and toxicity prevention.

Synthesis of Chitosan functionalized MWCNTs supported on Ni doped Bi₂S₃



Electrochemical oxidation of 5-ASA and 4-ASA



Electrochemical sensing mechanism on the Ni-doped Bi₂S₃-modified screen-printed electrode (SPE)

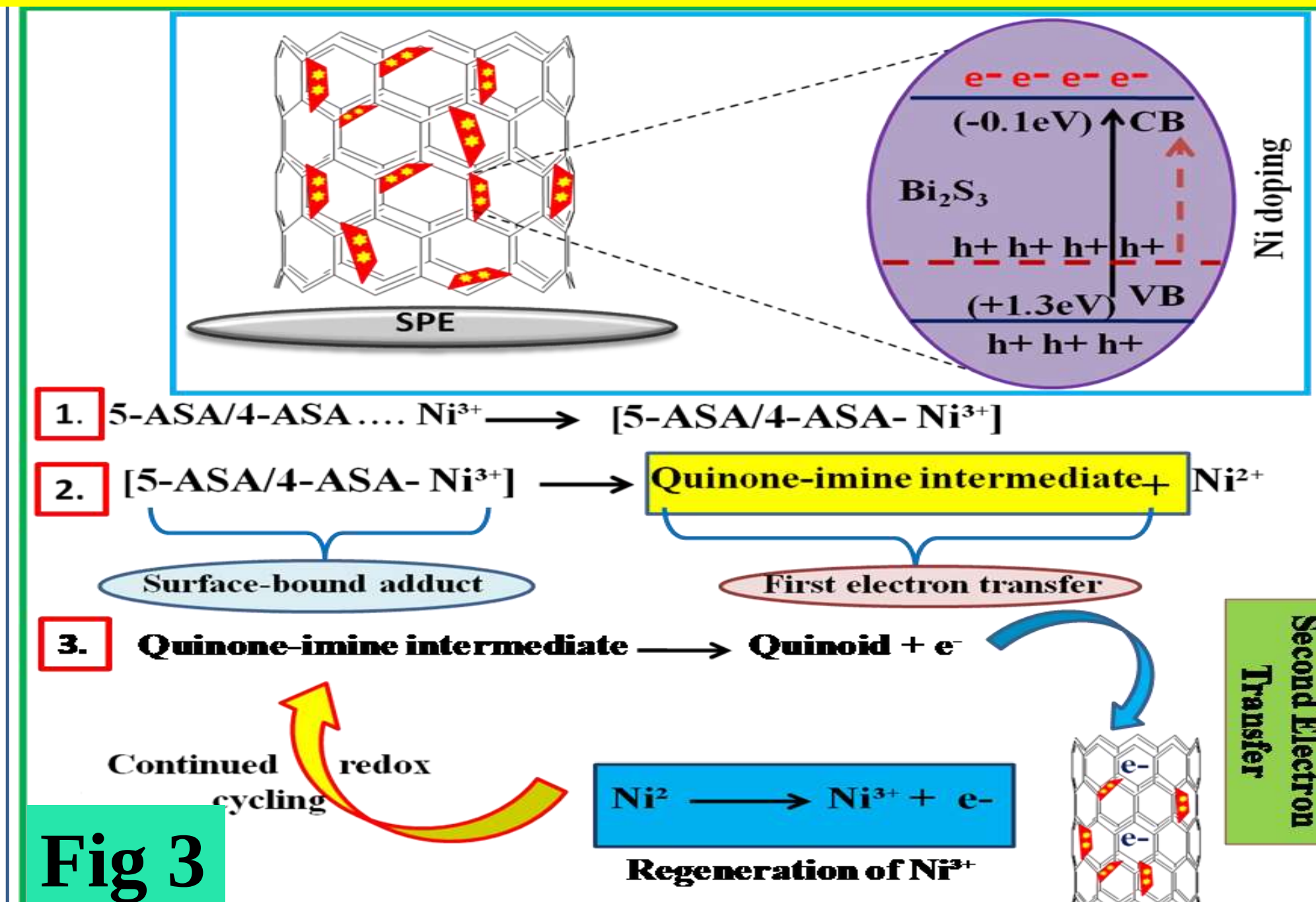
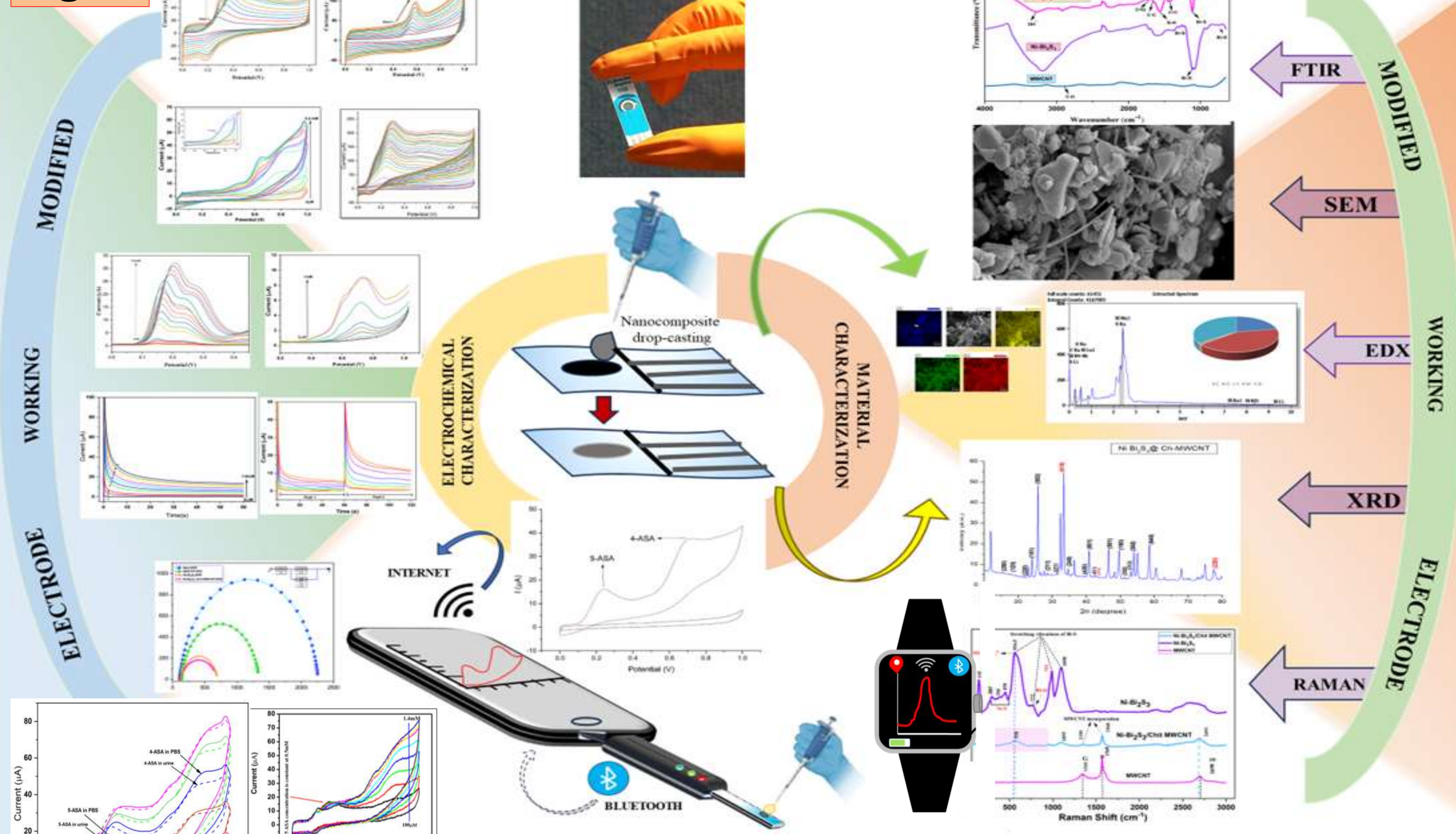


Fig 4



Key Findings

- ✓ **Detection Technique** Cyclic Voltammetry (and Differential Pulse Voltammetry, Chronoamperometry)
 - ✓ **LOD for 5-ASA** 39.559 μM and for **4-ASA** 85.21 μM
 - ✓ **Sensitivity for 5-ASA** 0.174 $\mu\text{A } \mu\text{M}^{-1} \text{cm}^{-2}$ and for **4-ASA** 0.139 $\mu\text{A } \mu\text{M}^{-1} \text{cm}^{-2}$
 - ✓ **Linear Dynamic Range for 5-ASA** 50–5750 μM and for **4-ASA** 100–2200 μM
 - ✓ **Catalytic Rate Constant for 5-ASA** $4.97 \times 10^5 \text{ M}^{-1} \text{ s}^{-1}$ and for **4-ASA** $0.496 \times 10^3 \text{ M}^{-1}$
 - ✓ **Selectivity** Minimal interference from common urinary constituents
 - ✓ **Real Sample Validation** Successful detection in human urine samples
 - ✓ **Recovery Rate of 5-ASA** 98–99.6% and for **4-ASA** 95.12–99.24%
- <https://doi.org/10.1016/j.chemosphere.2025.144425>

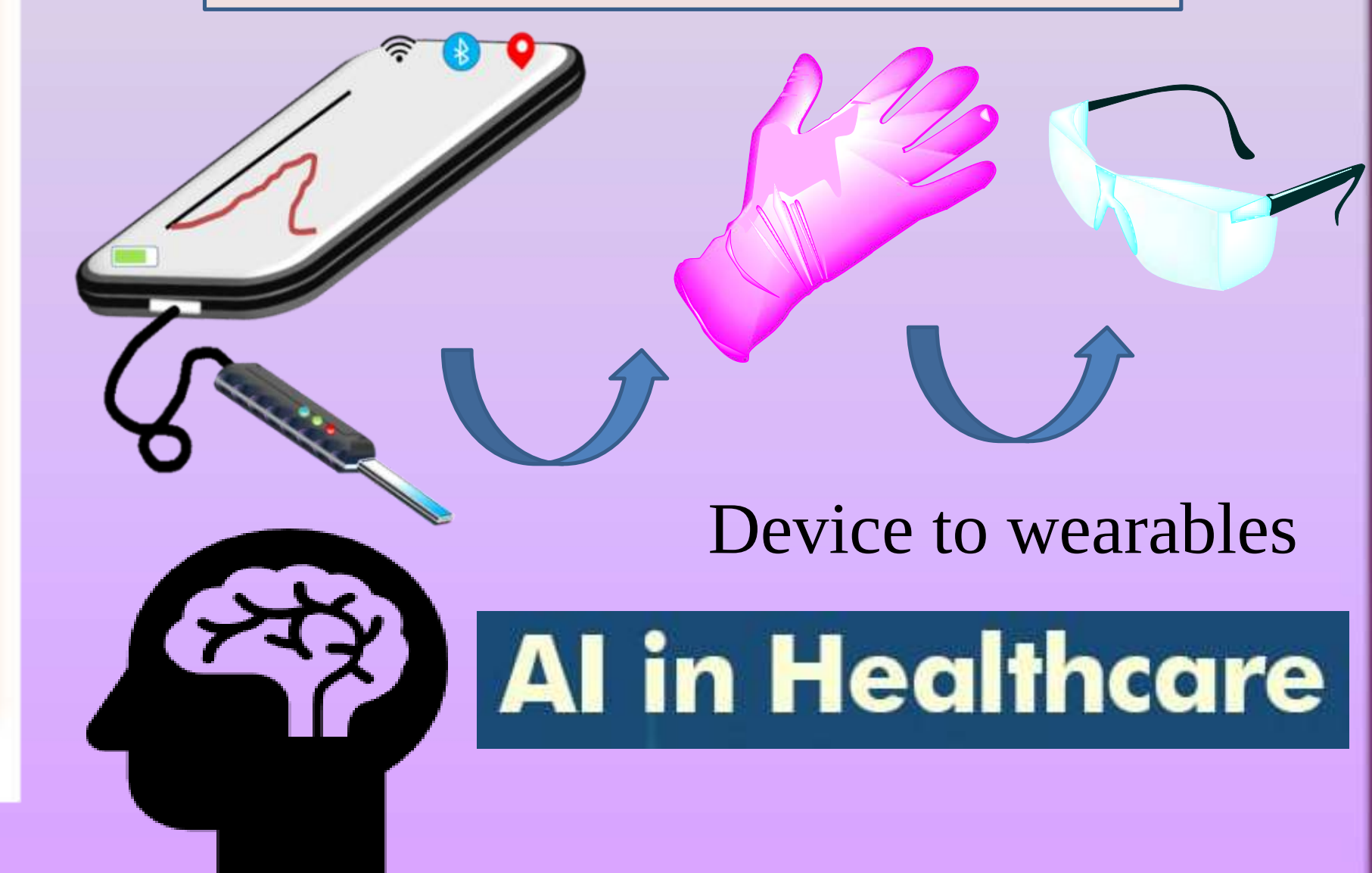
Applications

- ✓ Improved personalized healthcare
- ✓ Portable point-of-care diagnostic devices
- ✓ Potential applications in biomedical diagnostics

Conclusion

A novel Ni-doped Bi₂S₃/MWCNT/chitosan-based electrochemical sensor was successfully developed for the simultaneous detection of 4-ASA and 5-ASA. The platform demonstrated high sensitivity, good selectivity, excellent recovery in real urine samples, and compatibility with handheld devices, highlighting its strong potential for point-of-care diagnostics, therapeutic monitoring, and biomedical applications.

Future Endeavours



AI in Healthcare

How does it support SDG 3?

- Real-time detection of 4-ASA & 5-ASA
- Urine-based non-invasive analysis
- Point-of-care sensing
- Early toxicity monitoring

Supporting SDG 3: Good Health & Well-Being

Acknowledgement

The author sincerely acknowledges the support provided by the Department of Chemistry, BHU for research facilities and instrumentation support. The author also expresses gratitude to funding agencies; DST Inspire and Commonwealth Fellowships.