

Single-step solid-state synthesized 2H-NbSe₂ coated paper: A low-cost dual mode flexible platform (EC and SERS) for Tannic acid detection.

Surface-enhanced Raman scattering (SERS) has emerged as a powerful technique for ultrasensitive detection of analytes. In this study, we report the development of a SERS sensing platform for the detection of tannic acid, a polyphenolic compound with various applications in pharmaceuticals, food, and environmental monitoring. In this work, a SERS sensor was fabricated by coating paper substrate with 2H phase Niobium Di selenide (2H-NbSe₂) particles, leveraging the unique properties of NbSe₂ for enhanced Raman signal amplification. The NbSe₂ particles are synthesized via a simple and single step solid-state method. The paper substrate provides a convenient and portable platform for SERS sensing applications. Different characterization details of the as-synthesized NbSe₂ particles reveal its favourable surface morphology and chemical composition, making it suitable for enhancing Raman signals. The substrate exhibits an excellent linear range of detection from 0.1 ng/mL to 2.5 mg/mL of TA with a low limit of detection (LOD = 3.3s/m) of 0.057 ng/mL. The enhancement factor calculated is 3.41×10^6 at a low accumulation time of 25 s. This performance of the NbSe₂-based SERS substrate primarily stems from its physicochemical properties and the resulting mechanisms that bolster both physical and chemical interactions. The real time analysis in tap water resulted in decent recovery percentages from 93-115%. The paper-based sensor demonstrates a limit of detection 0.0026 ng/mL in a wide linear range of 0.01 ng/mL to 2.5 mg/mL. The strategy outlined here confirms that the solid-state NbSe₂ can be used as effective SERS and electrochemical substrates over other noble-metal-based substrates for a wide variety of bioanalytical and environmental applications, especially on-site detection of chemicals in water and other samples. This is the first report on paper based dual mode platform for tannic acid detection.