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APPLICATION NOTE

Characterisation of SERRS Nanoparticles Using UV-Vis and Raman Spectroscopy

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Introduction

Surface-enhanced resonance Raman scattering (SERRS) is a technique that offers unparalleled sensitivity and specificity in non-destructive spectroscopic detection. It is a combination of surface-enhanced Raman scattering (SERS) and resonance Raman spectroscopy (RRS), two techniques that are individually used to overcome the inherent weakness of Raman scattering.

SERRS occurs when an analyte, with an electronic transition frequency matching that of the excitation laser, is adsorbed on or near a roughened metal surface, such as that of noble metal nanoparticles (NPs), Figure 1. The theoretical Raman signal enhancements achievable using SERRS are orders of magnitude greater than SERS and RRS alone, meaning the analysis of trace or bio-detectable at very low concentrations. The technique is becoming increasingly popular in the fields of medical diagnostics and food science and is applied primarily via labelling methods that couple resonant Raman reporters with biocompatible moieties using optically tunable NPs. Such labelling methods can be applied to the detection of biomarkers in immunoassays, microfluidic devices, and label-free sensing, and when coupled with Raman microscopy, they can be utilised in the tracking of novel drugs or biomarkers in mammalian cells.

demonstrated through the Raman analysis of AuNPs functionalised with MG.

Materials and Methods

UV-Vis and Raman spectroscopic measurements were performed on Edinburgh Instruments DS5 Dual Beam UV-Vis Spectrophotometer and RM5 Raman Microscope, Figure 2. Spherical gold nanoparticle colloidal solutions were purchased from BB Solutions, and Malachite Green oxidate salt solution was purchased from Sigma Aldrich. Subsequent dilutions for both AuNPs and the MG solution were performed in distilled water. For UV-Vis absorption measurements, a 1.5 mL aliquot of the analyte was placed in a cuvette in the sample light path and water was placed in a cuvette in the reference light path. For Raman measurements, the objective turret of an RM5 Raman Microscope was equipped with a cuvette holder that allowed for the liquid samples to be measured under 633 nm and 785 nm excitation.

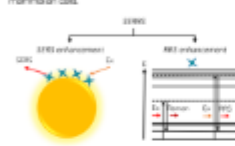


Figure 1: Schematic showing how SERS and RRS enhancement both contribute to SERRS effect.

To optimise SERRS of a nanoparticle sensor in various types of bioanalytical assays, it is imperative to understand the optical properties of the NPs and the electronic transition frequency of adsorbed reporter molecules. These factors can then be related to the Raman intensity produced. This understanding can be achieved by using UV-Vis spectroscopy and Raman spectroscopy in tandem. In this Application Note, UV-Vis spectroscopy is first used to explore the optical properties of a sample of gold NPs (AuNP) and Malachite Green (MG), a popular resonant Raman reporter molecule. Then, the enhanced sensitivity of SERRS over RRS and SERS is



Figure 2: Edinburgh Instruments DS5 Dual Beam UV-Vis Spectrophotometer (left) and RM5 Raman Microscope (right).

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Characterisation of SERRS Nanoparticles Using UV-Vis and Raman Spectroscopy

Surface-enhanced resonance Raman scattering (SERRS) is a technique that offers unparalleled sensitivity and specificity in spectroscopic detection and is promising for many applications in analytical research. In this new Application Note, we use the DS5 UV-Vis Dual Beam Spectrophotometer and RM5 Raman Microscope to demonstrate that the optical response of SERRS nanosensors contains combined SERS and RRS effects.

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