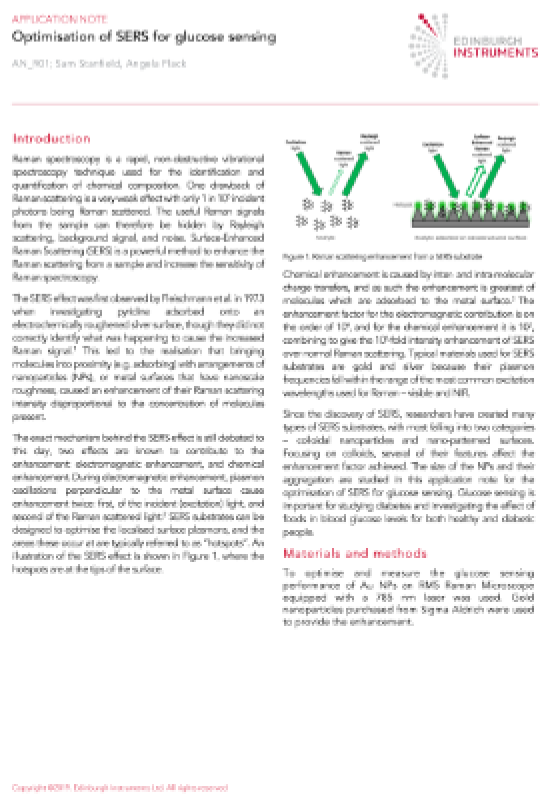
Tuesday, September 8, 2020

PHOTONICS spectra

WHITE PAPERS & APPLICATION NOTES



APPLICATION NOTE

Optimisation of SERS for glucose sensing

AN_901; Sam Stanfield, Angela Flack

EDINBURGH INSTRUMENTS

Introduction

Raman spectroscopy is a rapid, non-destructive vibrational spectroscopy technique used for the identification and quantification of chemical composition. One drawback of Raman scattering is a very weak effect with only 1 in 10[illegible] incident photons being Raman scattered. The useful Raman signals from the sample can therefore be hidden by Rayleigh scattering, background signal, and noise. Surface-Enhanced Raman Scattering (SERS) is a powerful method to enhance the Raman scattering from a sample and increase the sensitivity of Raman spectroscopy.

The SERS effect was first observed by Fleischmann et al. in 1973 when investigating pyridine adsorbed onto an electrochemically roughened silver surface, though they did not correctly identify what was happening to cause the increased Raman signal.[1] This led to the realisation that bringing molecules into proximity (e.g. adsorbing) with arrangements of nanoparticles (NPs), or metal surfaces that have nanoscale roughness, caused an enhancement of their Raman scattering intensity disproportional to the concentration of molecules present.

The exact mechanism behind the SERS effect is still debated to this day, two effects are known to contribute to the enhancement: electromagnetic enhancement, and chemical enhancement. During electromagnetic enhancement, plasmon oscillations perpendicular to the metal surface cause enhancement twice: first, of the incident (excitation) light, and second of the Raman scattered light.[2] SERS substrates can be designed to optimise the localised surface plasmons, and the areas these occur at are typically referred to as "hotspots". An illustration of the SERS effect is shown in Figure 1, where the hotspots are at the tips of the surface.

Figure 1. Raman scattering enhancement for a SERS substrate

Chemical enhancement is caused by inter- and intra-molecular charge transfers, and as such the enhancement is greatest of molecules which are adsorbed to the metal surface.[3] The enhancement factor for the electromagnetic contribution is on the order of 10[illegible], and for the chemical enhancement it is 10[illegible], combining to give the 10[illegible]-fold intensity enhancement of SERS over normal Raman scattering. Typical materials used for SERS substrates are gold and silver because their plasmon frequencies fall within the range of the most common excitation wavelengths used for Raman – visible and NIR.

Since the discovery of SERS, researchers have created many types of SERS substrates, with most falling into two categories – colloidal nanoparticles and nano-patterned surfaces. Focusing on colloids, several of their features affect the enhancement factor achieved. The size of the NPs and their aggregation are studied in this application note for the optimisation of SERS for glucose sensing. Glucose sensing is important for studying diabetes and investigating the effect of foods in blood glucose levels for both healthy and diabetic people.

Materials and methods

To optimise and measure the glucose sensing performance of Au NPs an RMS Raman Microscope equipped with a 785 nm laser was used. Gold nanoparticles purchased from Sigma Aldrich were used to provide the enhancement.

Copyright ©2019, Edinburgh Instruments Ltd. All rights reserved.

Optimisation of SERS for Glucose Sensing

Raman spectroscopy is a rapid, non-destructive vibrational spectroscopy technique used for the identification and quantification of chemical composition. One drawback of Raman scattering is a very weak effect with only 1 in 106 incident photons being Raman scattered. Surfaced enhanced Raman scattering (SERS) is an enhancement technique in which nanoparticles are used to provide Raman intensity enhancement. In this application note the optimisation of gold nanoparticles are investigated using Edinburgh Instruments Raman microscope for the development of a SERS glucose sensor.

DOWNLOAD WHITE PAPER

EDINBURGH INSTRUMENTS

More Application Notes from This Sponsor

- Electroluminescence and Photoluminescence Spectroscopy of a Phosphorescent Organic Light Emitting Diode (PhOLED)
- Photophysical Characterisation of Perovskite Quantum Dots
- Charge Carrier Recombination Dynamics of Semiconductor Photocatalyst

Visit **Photonics Media** to download other white papers and learn more about the latest developments in lasers, imaging, optics, biophotonics, machine vision, spectroscopy, microscopy, photovoltaics and more.

www.photonics.com/WhitePapers.aspx