Integrated Correlative Raman – Electron Microscopic Analysis of SERS Nanoparticles
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1. Abstract
A Raman microscope has been integrated in a Scanning Electron Microscope (SEM). This enables correlative optical micro-spectroscopy and high resolution electron microscopy analysis of any selected regions of interest (ROI). Having these microscopes integrated into a single system enables fast back and forth switching between SEM and Raman. This greatly improves the workflow [1]. The Raman – SEM microscope is used for the analysis of nanostructures with surface enhanced Raman spectroscopy (SERS). The combination of high resolution electron microscopy from nanostructures with Raman spectroscopic characterisation is used for a rigorous analysis of the SERS signal. The Raman signal enhancement is recorded for nanostructure of different shapes and sizes, thus enabling an analysis of the electric field enhancement based on the structure morphology. The experimental data is combined with simulations of the near field enhancement, as indicated in figure 1. Figure 1A shows the SEM image from a specific ROI containing 4 gold nanospheres. Figure 1B shows the Raman spectrum recorded on the same ROI. The Raman spectrum originates from the adsorbed rhodamine 6G reporter molecules. Figure 1C shows the calculated electric near field enhancement, of the object observed in the SEM image. An accurate correlative SEM – Raman analysis of many nanostructures is used to determine the signal enhancement and reproducibility of the SERS enhancement. SERS is known for high signal enhancements, but also for an unstable signal and large spread in signal strength. This makes the combination of SEM - Raman more interesting as it allows for an analysis of the signal variation for any observed nanostructure.

2. Figures

![Figure 1A](image1.png)

Figure 1A. SEM image of a group of 60 nm diameter gold nanoparticles, from the image a gap between the particles is observed of 13 and 37 nm. Figure 1B. Raman spectrum recorded on the same sample region, the spectrum is observed from the Rhodamine 6G reporter molecules that are adsorbed on the gold nanoparticles. Figure 1C. Calculation of the electric near field enhancement, the structure is designed based on the SEM image. The Raman signal enhancement factor averaged for all R6G reporter molecules in this simulation is 22.

3. References