EVALUATION OF SURFACE ENHANCED RESONANCE RAMAN SCATTERING (SERRS) FOR HIGHLY SENSITIVE AND HIGHLY MULTIPLEXED DNA ANALYSIS

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Abstract: This contribution reports on the use of surface enhanced resonance Raman scattering (SERRS) for the quantitative detection of dye labelled oligonucleotides. Detection limits for SERRS are reported as well as a direct comparison between the detection limits for SERRS and fluorescence.

The labelling of biological components is well established and common practice for detection using a wide range of techniques including micro arrays, ELISA, separation science and real time PCR. Currently fluorescent or chemiluminescent labels are the most widely used in biological characterisation and diagnostics. These labels generally offer a high degree of sensitivity, however when using fluorescence detection the signals are often limited by spectral overlap of the chromophores and by background signals due to other components in the sample.

Surface enhanced resonance Raman scattering (SERRS) [1-3] is an alternative technique which is also highly sensitive with single molecule detection reported [4,5]. Here it is demonstrated that by attaching labelled oligonucleotides to silver nanoparticles and using SERRS as the detection system, ultra low concentrations of DNA can be detected in a quantitative manner. The SERRS signals arise from the enhancement of the Raman scattered light by a roughened metal surface to produce a molecularly specific vibrational fingerprint consisting of sharp, characteristic bands and any fluorescence is quenched. The oligonucleotides were designed to absorb onto the silver nanoparticles when labelled by a range of different classes of commercially available fluorophores. This has allowed the detection of 8 different labelled oligonucleotides (HEX, TAMRA, R6G, CY3, CY5, ROX, FAM and TET) using SERRS at very low concentrations (see Figure 1) [6].

Due to the unique SERRS signals that can be obtained from the dye labelled oligonucleotides, the components in a mixture can be discriminated, allowing a high degree of multiplexing to be obtained without separation. Use of statistical analysis has provided increased power of identification in complex mixtures and indicates that SERRS offers significant advantages over fluorescence in terms of sensitivity and multiplexing power for DNA analysis. Data will be presented on the choice of label for optimal multiplexing and the theoretical limits of multiplexing.

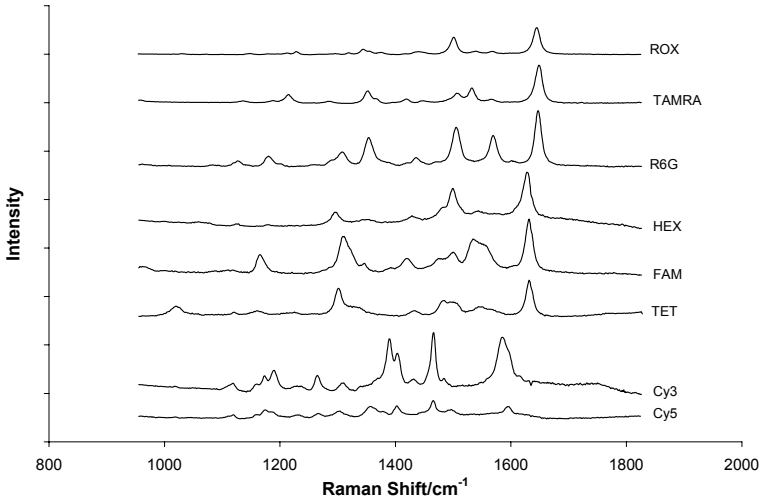

Fig. 1 SERRS spectra of the 8 dye-labeled oligonucleotides, obtained using 514.5 nm laser excitation at ~ 1 x 10^{-8} mol dm^{-3}.

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