Imperial College London

SPARTA™ –
Single Particle Automated Raman Trapping Analysis

SPARTA™ is a comprehensive nanoparticle analysis platform based on Raman spectroscopy providing simultaneous size, composition, and functionalisation analysis, as well as allowing live monitoring of dynamic reactions occurring on the surface of individual particles. The technology enables fast, high throughput, routine analysis of individual nanoparticles in solution without any need for particle labelling or modification.

Proposed use

The SPARTA™ platform is ideally suited to polymer and lipid systems but can be extended to a wide range of particle formulations with unique vibrational spectra.

The complimentary information obtained from this multifaceted platform, regarding particle composition, functionalisation, size, and dynamics, has enormous potential to critically impact fields including pharmacological drug development and delivery, gene therapies, clinical diagnostics, materials science, and cellular biology.

Problem addressed

The analysis of nanoparticles in a solution is a crucial step for a wide range of research fields including polymer particles and vesicles for drug delivery systems, such as liposomes and polymersomes. Particle sizing and compositional analysis is typically achieved by combining a range of laser-based diffraction and spectroscopic techniques but these multiple methods vary in sample requirements, such as concentration, preparation, and sensitivity, which can severely affect their function and applicability.

Enabling concurrent, high throughput analysis of single nanoparticles would greatly increase the capacity to study size, composition and inter- and intra-particle population variance with applications in a wide range of fields from polymer science to drug delivery. We present a comprehensive platform for Single Particle Automated Raman Trapping Analysis (SPARTA™). The SPARTA™ platform overcomes key limitations in sensitivity and specificity of existing bulk analysis methods.

Technology overview

The SPARTA™ system is based on a high-end confocal Raman spectroscopy set-up where the laser, camera and spectroscope are simultaneously controlled via custom, in-house MATLAB scripts, for automated single particle trapping and Raman spectral acquisition.

Benefits

- The SPARTA™ platform can analyse hundreds of single particles, of varying size and composition, in an automated fashion and with a high signal-to-noise ratio (SNR)
- It avoids checking the same particle twice due to a tightly controlled automation of the trapping process
- Very flexible and easy to use set-up, allowing the user to set the desired acquisition parameters for each experiment via a dedicated GUI (Graphical User Interface)
- The SPARTA™ platform is capable of estimating the size of individual nanoparticles in the laser trap, while simultaneously acquiring their compositional data

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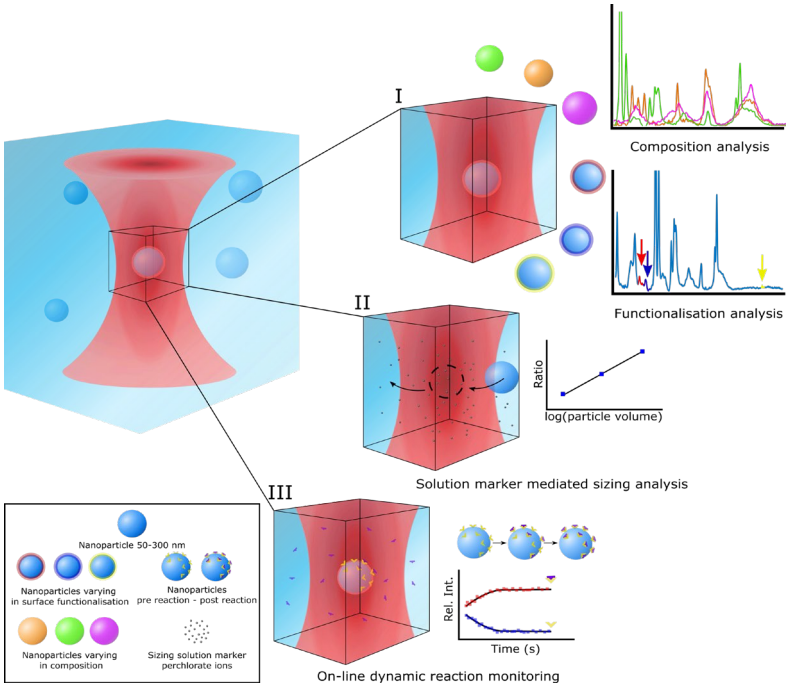

To enable the application of SPARTA™, the inventors developed three distinct modes of operation:

I.

The first mode comprises the functionalisation and composition analysis by acquisition of high quality Raman spectra for single particles in solution, allowing investigation of their composition and verification of the presence of specific functionalisation.

II.

The second mode is a solution marker mediated sizing analysis. By combining the high throughput single particle analysis with a perchlorate ion standard, the size of the particle in the trap can be estimated simultaneously when acquiring its compositional information.

III.

The third mode is an on-line dynamic reaction monitoring tracking the progress of a dynamic event on single particles. This can be achieved by either holding a single particle in the trap for the duration of the reaction, or by trapping a new particle at subsequent time points to compare reaction progress on a particle by particle basis.

Intellectual property information

WO2019243375A1 SINGLE PARTICLE AUTOMATED RAMAN TRAPPING ANALYSIS

Penders, Stevens et al., Nat. Commun. 2018

Inventor information

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