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Ensuring High Throughput in All Aspects of Automated Particle Analysis

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Particle (or Feature) Analysis is an important technique on the scanning electron microscope – finding applications in both research and industrially oriented settings. It is an approach which brings together many of the operations which are often performed manually on the SEM such that the identification, analysis, and, to an extent, the interpretation (by means of classification of the detected features) of large datasets across extensive (on the scale of analysis in the SEM) samples can take place automatically. This approach has several key advantages compared to its manual counterpart.

Firstly, automated particle analysis significantly saves on labour – freeing up operators to focus on other tasks and allowing instruments to be run without human input at antisocial times. Secondly, it has the effect of removing bias – by automating the process of choosing what to analyse – or at least if bias is introduced it is done so via a planned action. Thirdly, it allows a degree of interpretation to be performed by allowing the detected particles to be grouped according to their properties.

The approach is typically based on the acquisition of backscattered electron (BSE) images from which particles are detected based on grey level. Particles are then measured for morphology before Energy Dispersive X-ray Spectroscopy (EDS) acquisitions are performed to allow a measurement of composition. The combined morphological and compositional information is then passed through a classification scheme.

With these powerful capabilities, particle analysis has been widely adopted. This adoption has brought several priorities related to the approach into focus – particularly that of throughput.

By its very nature, characterising a particulated/feature sample automatically is a far faster process than manual analysis – even in its most basic implementation. By utilising automation and algorithms to take over processes such as feature identification and morphological measurement, a huge amount of time is saved. However, by employing a series of advanced strategies targeting *both in-run processes and the set-up and interpretation of data outside of the run*, throughput can be significantly improved. Figure 1 shows a representation of a basic feature run, without optimisations, and how potential optimisations relate to it.

In this submission we discuss how the combination of the latest generation of Energy Dispersive X-ray Spectroscopy detectors combines with advanced spectrum processing algorithms to ensure that the basic work of automated particle analysis – acquiring EDS data from the detected particles is done as quickly and accurately as possible. We then discuss how the combination of this technology with dedicated software routines and processes improves the overall time to result.

Approaches which will be discussed include:

- Using multi-pass imaging techniques for ensuring the detection of small particles whilst working at relatively low magnifications. This approach makes it possible to perform the run with the throughput controlled by a rapid image acquisition speed but with the accuracy of detection controlled by a slower imaging speed.
- How, by using a carefully planned particle detection process, we can take the opportunity to decide which particles to analyse based on specific criteria based on a wide range of measured particle parameters – thereby allowing us to reduce analysis time by only analysing those particles that are of the greatest interest.

- The use of pre-scanning of samples to allow faster analysis when there is a desire to only analyse a proportion of the particles present. This approach takes advantage of the heterogeneity of distribution of particles to define an optimised field acquisition order.
- Batch management of multiple analysis runs for the reduction of setup times.
- The use of pre-defined, multi area analysis layouts for rapid run definition (e.g. Figure 2).

We will discuss how these approaches can be used either in isolation or in combination and how the specific throughput improvement that they achieve will depend on the application in question. This will be illustrated with real-world examples drawn from a range of research areas and industries.

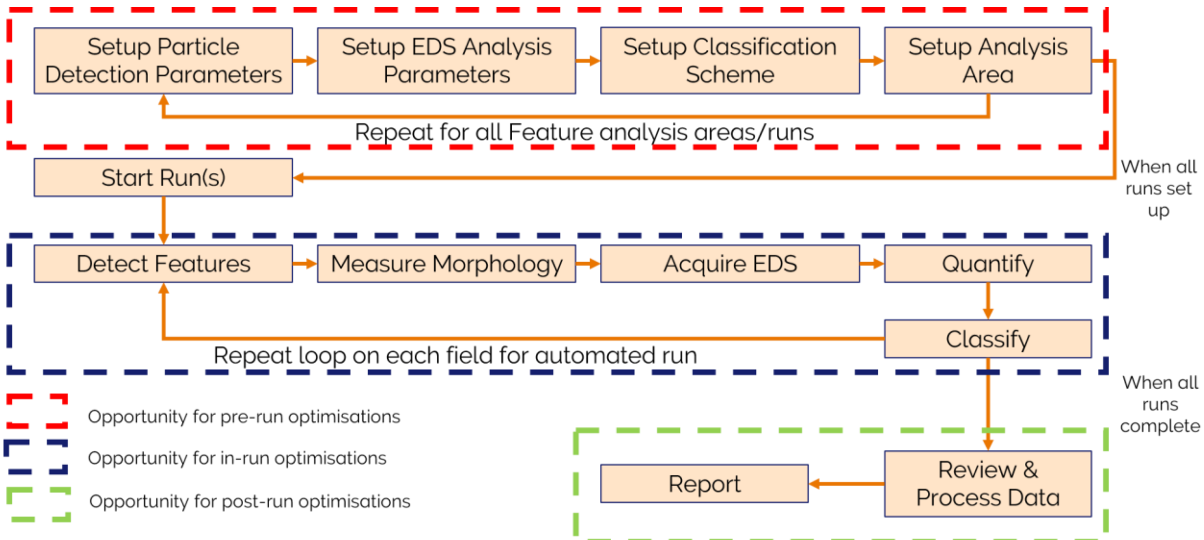

Figure 1. Workflow representation of a basic Feature analysis and opportunities for optimisation

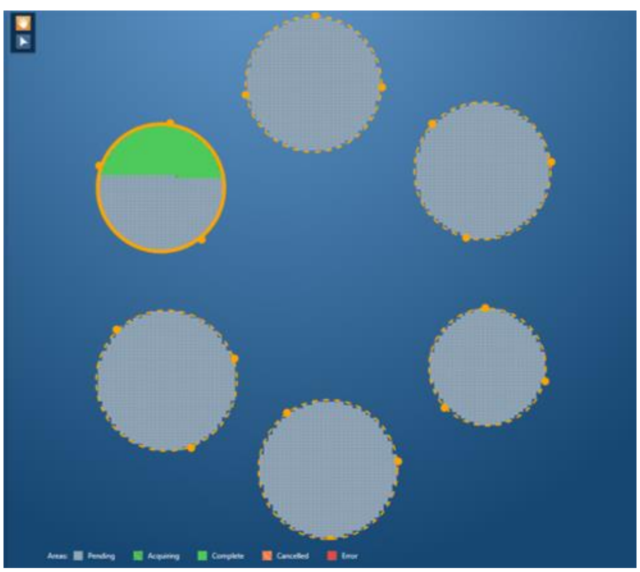

Figure 2. Pre-defined layout consisting of 6 areas for automated analysis - being able to recall areas for analysis greatly speeds up run setup

References

None

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