Eykes: a new software application for analyzing Transmission Electron Microscopy images of nanoparticles

P. Ruiz[1], F. Courteille[2,3], J. Macanás[1].
[1] Analytical Chemistry Division, Department of Chemistry, Autonomous University of Barcelona, 08193 Bellaterra, Barcelona, Spain.
[2] Laboratoire Génie Chimique, Université de Toulouse, INPT, UPS, Toulouse (France)
[3] Laboratoire Génie Chimique, CNRS, Toulouse (France)
Jorge.Macanas@uab.cat

Synthesis and characterization of metal nanoparticles (MNPs) are topics of interest in many applications such as device fabrication, quantum computing, catalysis and sensing due to their special physical and chemical properties which are directly related to their size [1].
Further advancement of Nanotechnology needs a better understanding of nanomaterial properties and implies a better characterization of key parameters such as nanoparticle size and size distribution which are frequently evaluated by using Transmission Electron Microscopy (TEM), a well known microscopy technique, capable of imaging at a significantly higher resolution than light microscopes [2]. Unfortunately, in practice, TEM images are particularly noisy and low contrasted, making their processing a challenging task to accomplish. Thus, results from TEM images have been often obtained by manually measuring and counting many nanoparticles, a task that is highly subjective and labor intensive.
During these last years, several computer imaging particle analysis software tools have been conceived for extracting automatically (or semi-automatically) useful information contained in images what may allow for a more accurate assessment of the size and frequency (size distribution) of nanoparticles. However, sometimes these tools are included in very expensive software packages impossible to be afford by many research groups. In addition, some of these tools are not easy to be used by non-experts mainly because of the subjectivity of the thresholding step [3,4,5,6,7,8,9].
In this work, we report the development of a new software solution for nanoparticles counting (Eykes) and compare it with manually obtained data. The main characteristics of this software application are its ease in performance and its compatibility with many images difficultly analyzed by standard software.
Concretely, for the image analysis, we consider only two phases (solid objects and void) and, therefore, the image processing algorithm is very simple. After enhancing contrast, we perform an image denoising by applying smooth filters (gaussian and median filters). Then, we split the image in several sub-images, and for each sub-image, we apply a simple threshold by using the Otsu algorithm. In the final image each particle is identified, numbered and characterized. In **Figure 1** a typical set of images is shown demonstrating the excellent nanoparticle recognition provided by the software.
The statistical treatment of data (for histogram representation and so on) is not included in the software package since each researcher has its own preferences for data representation but all the extracted information is written in a file which can be imported in any other statistics software tools.

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Figures:

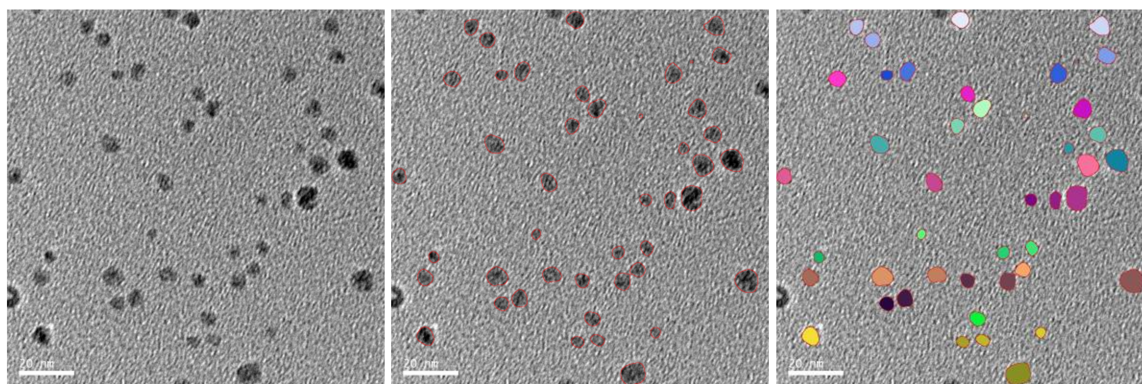

Fig. 1 Typical TEM images of polymer stabilized Cu nanoparticles. Original image (left) and analyzed images (center and right).