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A Multiple-image Nanofiber Diameter Measurement Tool

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ABSTRACT

In recent years, nanofibers are increasingly used in many fields such as textiles, catalysis, sensors, filtration, and tissue engineering. Therefore, a reliable, validated and automated analysis method for characterizing nanofiber morphology from scanning electron microscope (SEM) micrographs is strongly needed for all these applications. The common methods that determine the nanofiber diameter manually, are time-consuming and can be easily biased during the operation. Several commercial software development labs have developed SEM image analysis tools to automatically assess nanofiber's orientation and diameter from a single-image analysis. However, the magnification and picture resolution can largely influence the results of nanofiber diameter. Therefore, there is a great need for a more accurate image analysis tool that can process multiple images automatically, making the result less affected by image resolution.

This study aimed to develop an image processing code to determine nanofiber morphology from multiple images using MATLAB. This tool can process two images with a different magnification of one sample at the same time. On one hand, the low-magnification image contains a larger area of the sample, providing more sampling points and a more realistic result. On the other hand, the high-magnification image can offer a more accurate diameter for low fiber size diameters. After utilizing the data from both images, this tool will automatically draw a distribution diagram contains three data sets, the low magnification data set, the high magnification data set and the combined data set, giving more statistically reliable results.

In this study, median filtering, image intensity adjustment, and histogram equalization are used to reduce noise and increase the contrast of images. A local thresholding method is utilized to transform the image into a binary image using Sauvola binarization. The fiber boundaries are detected using canny edge detection. Then the fiber diameters are calculated by Euclidean distance transform matrix. These procedures ensure the analysis quality of each image and the multiple-image function makes this nanofiber diameter measurement tool more accurate and realizable than other single-image analysis ones.