Automated Classification of Scanning Electron Microscope Particle Images using Morphological Analysis

Brian L. Marcha1, Robert R. Lewis1, Donald C. Girvin1, James F. McKinley1 - Pacific Northwest National Laboratory ‘School of EECS, Washington State University

Introduction

We are developing a software tool that can automatically classify anthropogenic and natural aerosol particles using morphological analysis. Our method was developed using background and secondary scanning electron microscope (SEM) images of single particles. Particle silhouettes are detected and converted into polygons using Intel’s OpenCV computer vision library. Our analysis then proceeds independently for the two kinds of images.

Segmentation

Using a shape-based approach to detect the particles in convergent SEM images, we can isolate areas of a particle and avoid analysis of speckle noise. Morphological properties of the extracted shape features are then fed into the clustering algorithms. However, our parameters are robust for automated analysis. Therefore, we have developed a segmentation technique that endures an adaptive threshold algorithm with adjustable threshold that is applied to the particles to remove any background.

Shape Analysis

A particle’s perimeter is parameterized using the skeleton method provided by the Intel OpenCV computer vision library. As shown below, the perimeter is defined using the thickness of the skeleton. From here, we can calculate the area, contour length, and shape factors for each particle.

Texture Analysis

Images of SEM images contain the local texture, which is the result of both composition and geometry. Using the skeleton as a boundary, we compute the orientation, a statistical measure of the ratio of coarse to fine texture. We then compute a set of parameters that measure the texture. A particle’s internal coarseness affects the visual texture of the fabricated SEM (FSEM) image. The images shown here demonstrate the variation in texture.

Classification

In integrating discrete overlapping bands of a particle’s power spectrum, we can reduce its dimension to a few parameters. These descriptors can identify distinct shape features. By using the parameter from the various analyses, we can quantify distinct material differences among particles.

Summary

We have developed a technique to automatically segment particles from both secondary and backscatter SEM images. The resulting sub-image used for both textual and shape analysis. We are exploring ways to parameterize both shape and texture. Our methods allow us to reduce a large problem space to a smaller one without parameterization. This is useful for automated analysis of large quantities of SEM particle images. Furthermore, we can encompass multi-particulate images through modifications in our segmentation algorithm.