



Bridge You and Nano

Exponential Business and Technologies Company

Particle Sizing and Feret Diameter Analysis using Microscopy

Feret diameter analysis is an image-based particle characterization method used to quantify the size and shape of particles; which is particularly useful when studying particle suspensions using microscopy. The Feret diameter is the distance between two parallel tangents on opposite sides of a particle's projected image. The longest possible distance between tangents is the maximum Feret diameter, and the shortest possible distance between tangents is the minimum Feret diameter. The ratio of maximum and minimum Feret diameters, or the aspect ratio (length/width), shows how circular a sample is, with an aspect ratio of 1 representing a perfect circle. In addition, the minimum Feret diameter often correlates with particle separation using sieves, and the maximum Feret diameter can be used to track particle aggregation behavior.

Microscopy images of particle suspensions can often contain hundreds to thousands of particles. At Ebatco NAT Lab, microscopy images can be obtained using traditional imaging optics, FTIR, Raman, and scanning electron microscopy. We can use these microscopy images and our imaging analysis software to perform Feret diameter analysis to determine the particle size, count, area, and shape. Figure 1a shows an SEM image of a dried particle suspension deposited on a silicon substrate and Figure 1b shows an optical image of kosher salt spread out on a red surface. Figures 2 and 3 show the minimum and maximum Feret diameters of the particles from Figure 1a and Figure 1b, respectively. In Figure 2, there are two normal distributions, one for minimum and one for maximum Feret diameter. The mean minimum Feret diameter is $3.10\text{ }\mu\text{m}$, which agrees well with the manufacturer supplied value of $3\text{ }\mu\text{m}$. The mean aspect ratio is 1.45, indicating some irregularity in shape and minimal aggregation. The analysis for kosher salt in Figure 3 also appears to have two normal distributions, with a mean minimum Feret diameter of 1.33 mm and a mean aspect ratio of 1.48. These results demonstrate that Feret diameter analysis is an effective and accurate method to characterize particles when high resolution images can be obtained.

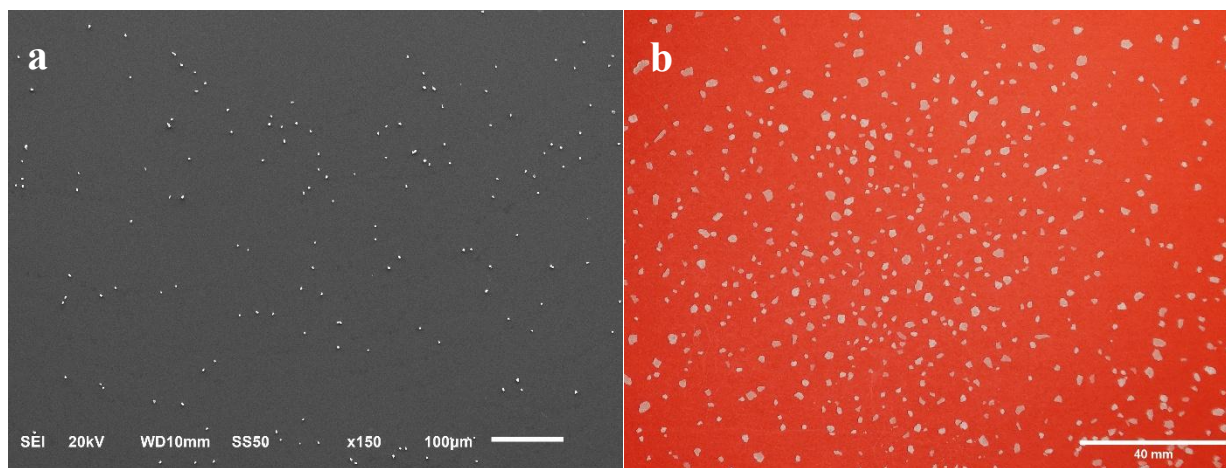


Figure 1. a) 2,000x magnification SEM image of a particle suspension deposited on silicon, and b) 3.75x optical microscopy image of kosher salt dispersed on a red surface.



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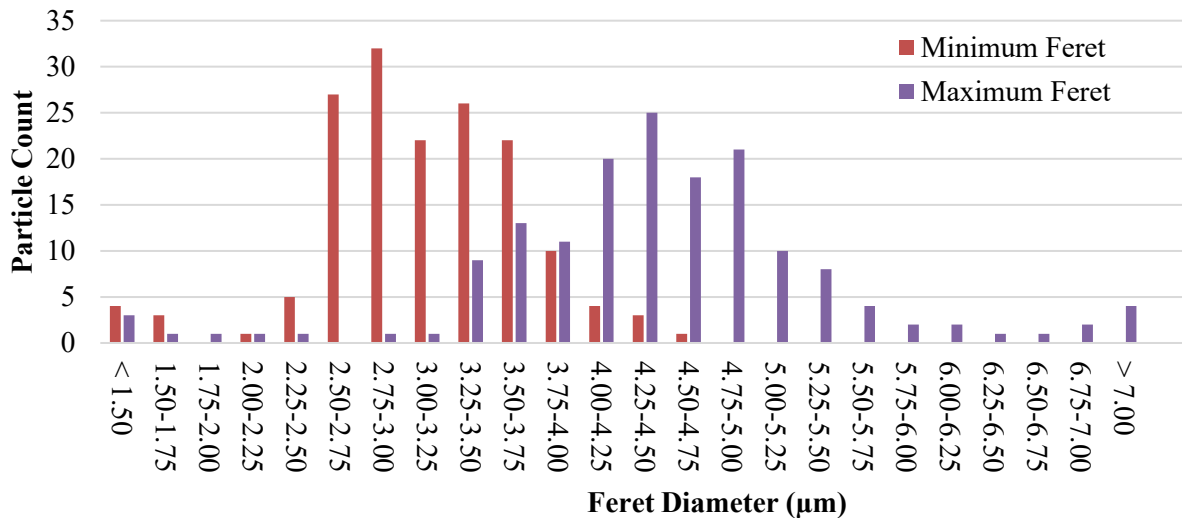


Figure 2. A histogram showing the minimum and maximum Feret diameter distribution of the polishing suspension particles shown in Figure 1a.

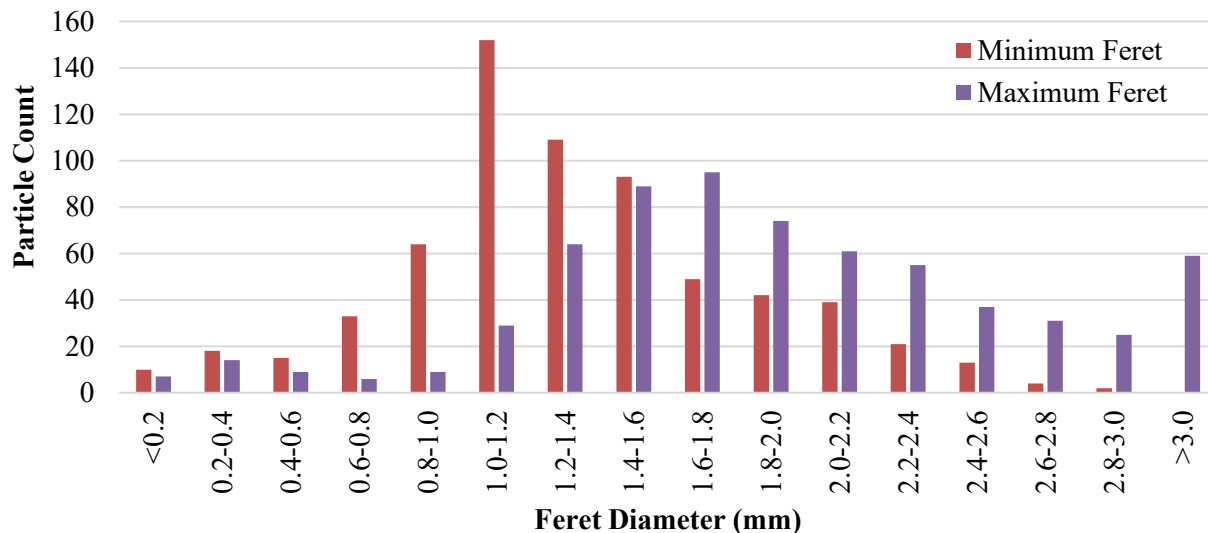


Figure 3. A histogram showing the minimum and maximum Feret diameter distribution of the kosher salt particles shown in Figure 1b.

Particle size analysis is necessary in fields sensitive to size discrepancies. Pharmaceuticals tend to interact with the body at a rate that correlates to the particles' surface area. Large particles or aggregates in polishing slurries that are used to create ultra smooth surfaces can introduce unwanted scratching or roughness. Semiconductor nanomaterials often have size-dependent electronic properties, and it is essential to know a suspension's size dispersity before using it to fabricate devices. Using Feret diameter analysis to measure a particle dispersion's shape and size can derive essential information from microscopy images at vastly different length scales.