FLUID IMAGING TECHNOLOGIES

FlowCAM® Front-Fill™ Illumination Option

Imaging Particle Analysis with Brightfield *and* Darkfield Illumination

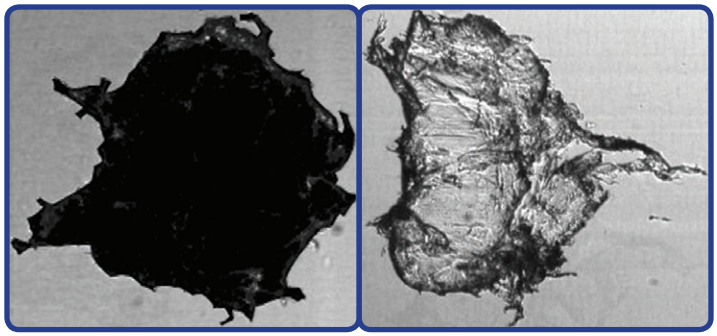

Figure 1: Brightfield image of Teflon® particle on left. On right, another Teflon particle after adding Front-Fill™ illumination.

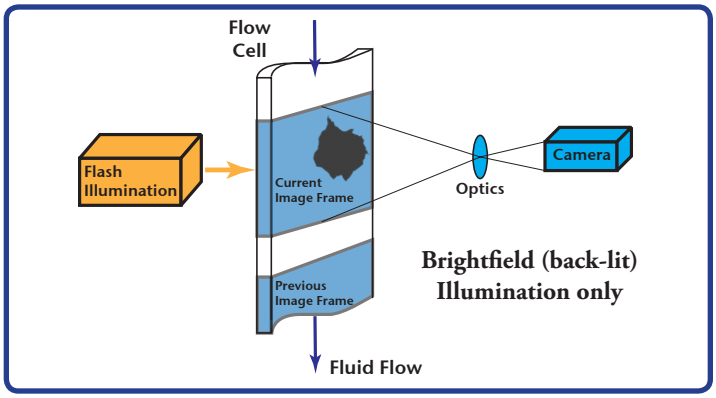

Figure 2: Standard back-lit only system produces "silhouette" images of opaque particles.

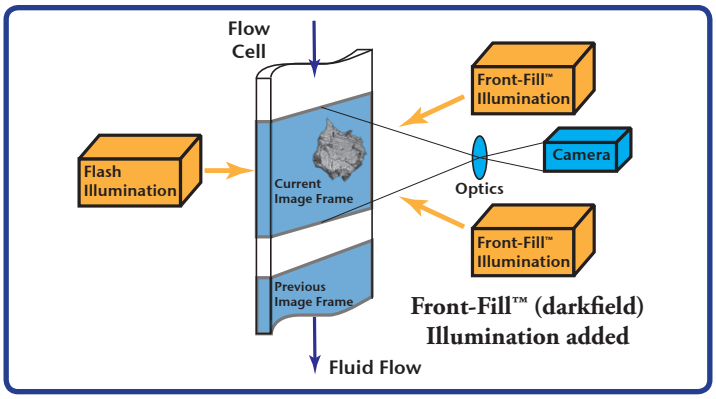

Figure 3: With the addition of Front-Fill illumination, surface details such as texture are seen on the same particle.

Dynamic imaging particle analysis systems such as the FlowCAM® are usually "brightfield" illuminated, where the illumination for the particles is from behind the particles pointing towards the camera. As the name implies, this means that the overall field that the camera sees is "bright", and that particles that pass through the field will be darker than the background. One of the primary reasons for doing this is that it gives lots of light back to the camera's sensor. This is important because more light allows use of a faster shutter speed in order to "freeze" the particles that are in motion in a flow-through system.

Brightfield illumination works very well for particles that are at least partially transparent. In fact, one of the reasons why brightfield is so common in microscopy is that historically the majority of subjects were cells, which typically are transparent.

However, when opaque particles pass through a brightfield system, they will create essentially a "silhouette" image because they completely block the illumination coming from behind the particle (see Figure 1, left, and Figure 2). Because of this high contrast, the camera will see no detail on the side of the particle facing it. With the FlowCAM® Front-Fill™ illumination option, however, detail on the particle side facing the camera can be revealed (see Figure 1, right, and Figure 3).

FlowCAM® Front-Fill™ Benefits:

- See texture on opaque particles
- See color of opaque particles
- Add detail to semi-transparent particles
- Variable level of Front-Fill illumination
- Variable level of brightfield illumination
- "Dial in" most useful combination of lighting for each sample (balanced illumination)
- Extra information gained from Front-Fill can lead to better automated particle differentiation using the VisualSpreadsheet™ pattern recognition capabilities

The FlowCAM® Front-Fill™ illumination option overcomes the limitations of brightfield illumination for opaque particles. By adding in an additional Front-Fill light source to the FlowCAM, the side of the particles facing the camera can be illuminated to reveal surface details such as texture or color, for example, on these opaque particles. The system with this option has the ability to "balance" the combination of darkfield and brightfield illumination to best fit the particular sample being run.

For example, in a 100% opaque sample, the Front-Fill will need to be turned up in order to reveal details on the particle side facing the camera. On the other hand, in a partially transparent sample, only a small amount of Front-Fill is warranted to augment the brightfield illumination.

Example:

A sample of superabrasives was run through the FlowCAM® using both standard and Front-Fill™ illumination to compare the results. Since these particles are completely opaque, they appear as "silhouettes" when imaged using just standard brightfield illumination, as can be seen if Figure 3. When the same sample is run with Front-Fill illumination added, surface detail on each particle facing the camera can now be clearly seen as in Figure 4.

Not only do the images show the differences, but the particle measurements will also reflect the differences in certain gray-scale measurements such as average intensity, transparency, etc. This can be seen in Figure 5, where the average intensity for the Front-Fill particles is 114 (0-255 scale) versus 58 for the brightfield-only particles. These differences in particle intensity could be used to differentiate one type of particle from another in pattern recognition. For example, metallic particles which reflect light could be easily picked out from non-metallic ones in the same sample.

Front-Fill™ is yet another unique capability of the FlowCAM® for differentiating different particle types in a heterogeneous sample. Contact us today to learn more!

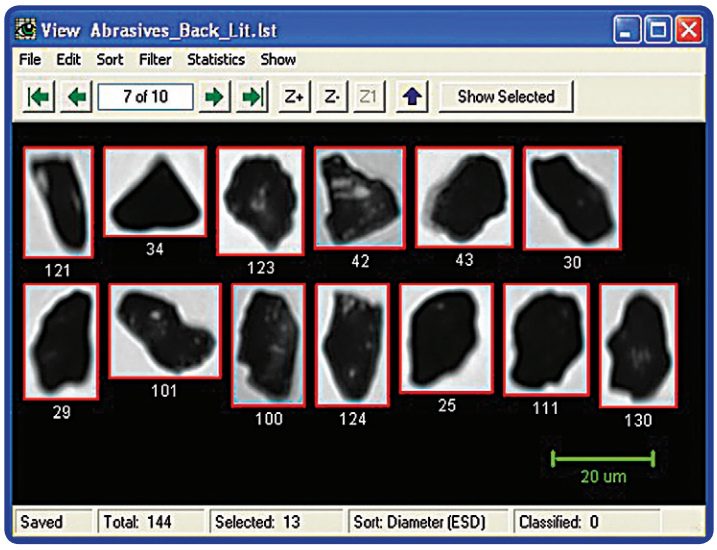

Figure 3: Superabrasive particles with brightfield lighting only.

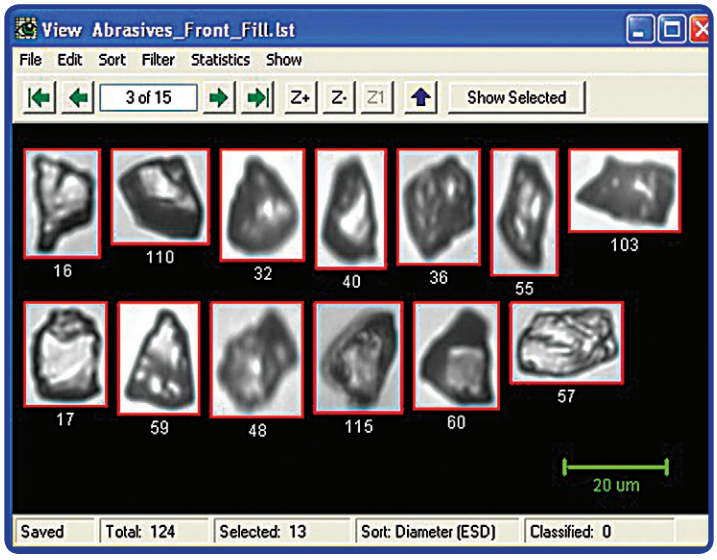

Figure 4: Superabrasive particles with Front-Fill illumination added.

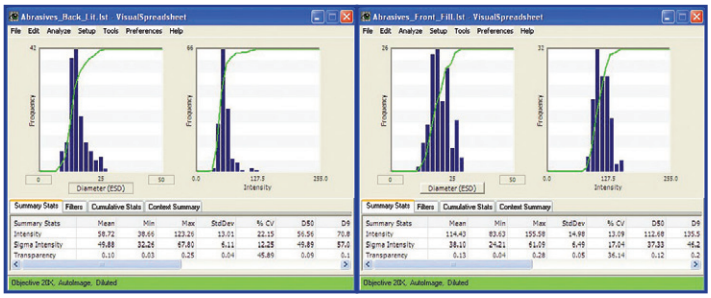

Figure 5: Summary graphs and statistics show higher average intensity for the Front-Fill particles.