Particle Shape Analysis

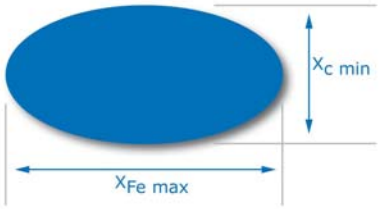
In many industries particle size analysis has become a routine that is applied in various steps of the production process. In addition to measuring the particle size, particle shape analysis has grown more and more important.
For quality assurance purposes it is sometimes vital to detect differences in the particle shape of different charges as it may have a huge influence on certain product characteristics, e.g. flow behaviour or abrasion, and can therefore help to draw conclusions on flaws in the production process. The knowledge of the particle shape enables to affect product characteristics, optimize production processes and minimize production costs. For that reason it is very important to have a convenient, reliable and fast particle analysis, so that you can have an immediate influence on the current production.

Particle shape can be measured using automated image analysis techniques that, in contrast to manual analysis techniques like microscopy, generate statistically relevant data. Due to the fact that image analysis can create number related distributions, it is also applicable for very small samples with very fine particles. The possibility to visually analyze the particles via the images of the camera additionally allows to detect agglomerates and contaminants very easily.
Digital image processing in the CAMSIZER is done by recording particles that shadow the light of a light source with two CCD cameras. These images are processed in a way that after the measurement not only the individual images can be seen, but also the particle shape parameters are displayed as actual numeric values and are therefore comparable. These values refer to defined parameters that describe different particle shape characteristics.

The following four particle shape parameters are most commonly used:

1. Expansion; Breadth-/Length-Ratio $\frac{X_{c\ min}}{X_{Fe\ max}}$

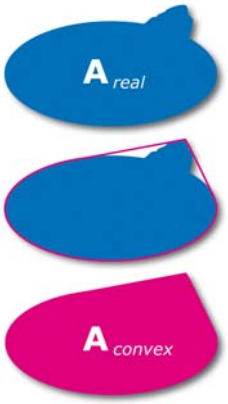
The expansion describes the ratio between the breadth and the length of a particle projection. Here, $x_{c\ min}$ corresponds with the breadth, while $x_{Fe\ max}$ is the maximal expansion of the particle. Globular particle images have an expansion near one, spicular particles have an expansion near zero.



Therefore this parameter gives a hint on the macro shape of the particle itself.

2. Convexity $\sqrt{\frac{A_{real}}{A_{konvex}}}$

The convexity describes the surface properties of a particle and can be calculated by dividing the real projection area by the area of the “convex shell”. The “convex shell” can be described best through an imaginary elastic strap that is wrapped around the particle. A smooth surface where all concavities are filled for example therefore has a convexity value near one, while particles with an uneven or rough surface would reach a lower value.

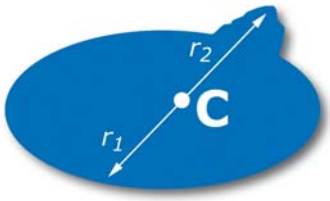


3. Roundness $\frac{4\pi A}{P^2}$

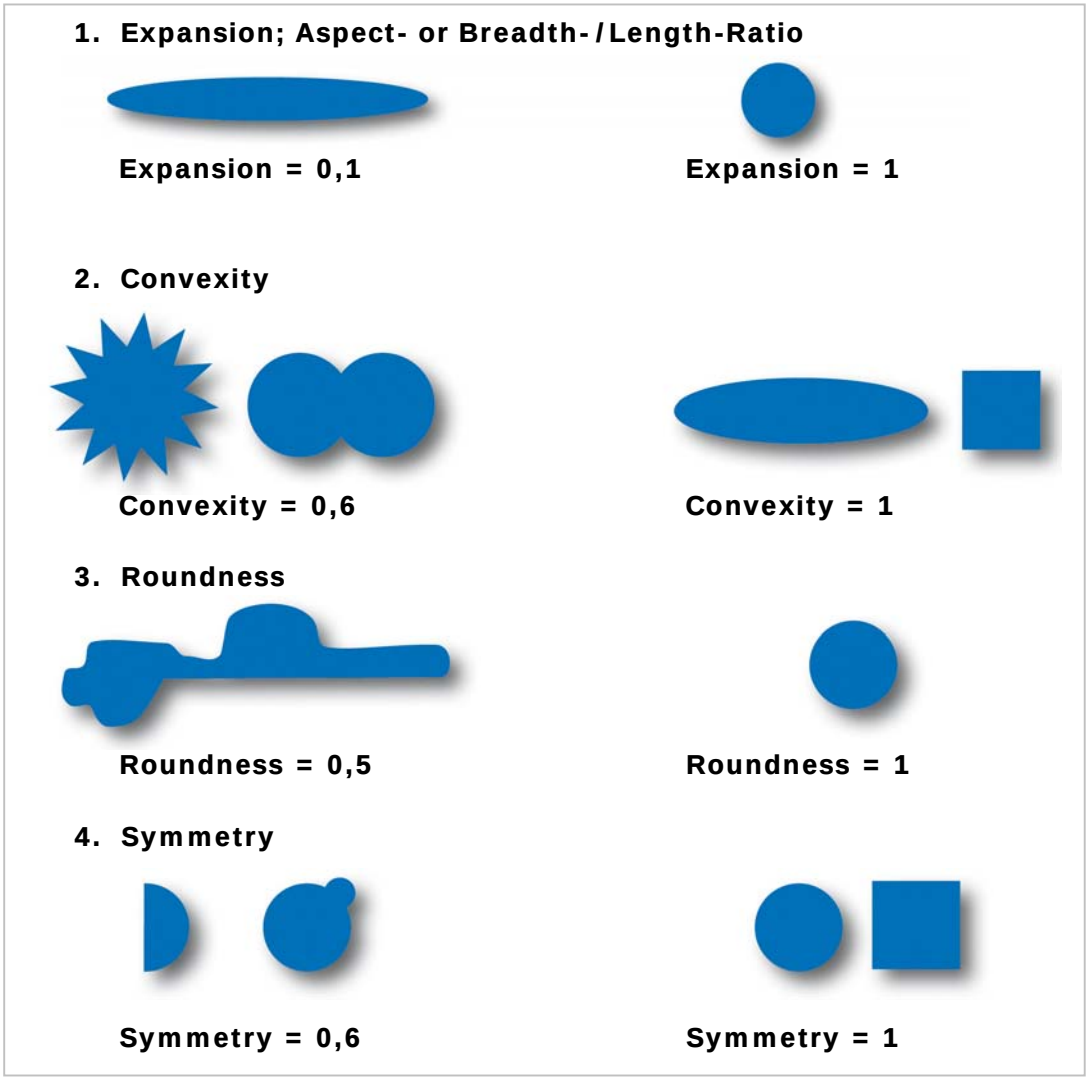
The roundness describes the ratio between the area of a particle image and the perimeter. Therefore a globular particle would have a roundness near one, while an irregularly jagged particle has a lower roundness value. This form parameter is very important for quality surveillance, especially when the obtained particles need to be as round as possible.

4. Symmetry $\frac{1}{2}\left(1+\min\left(\frac{r_1}{r_2}\right)\right)$

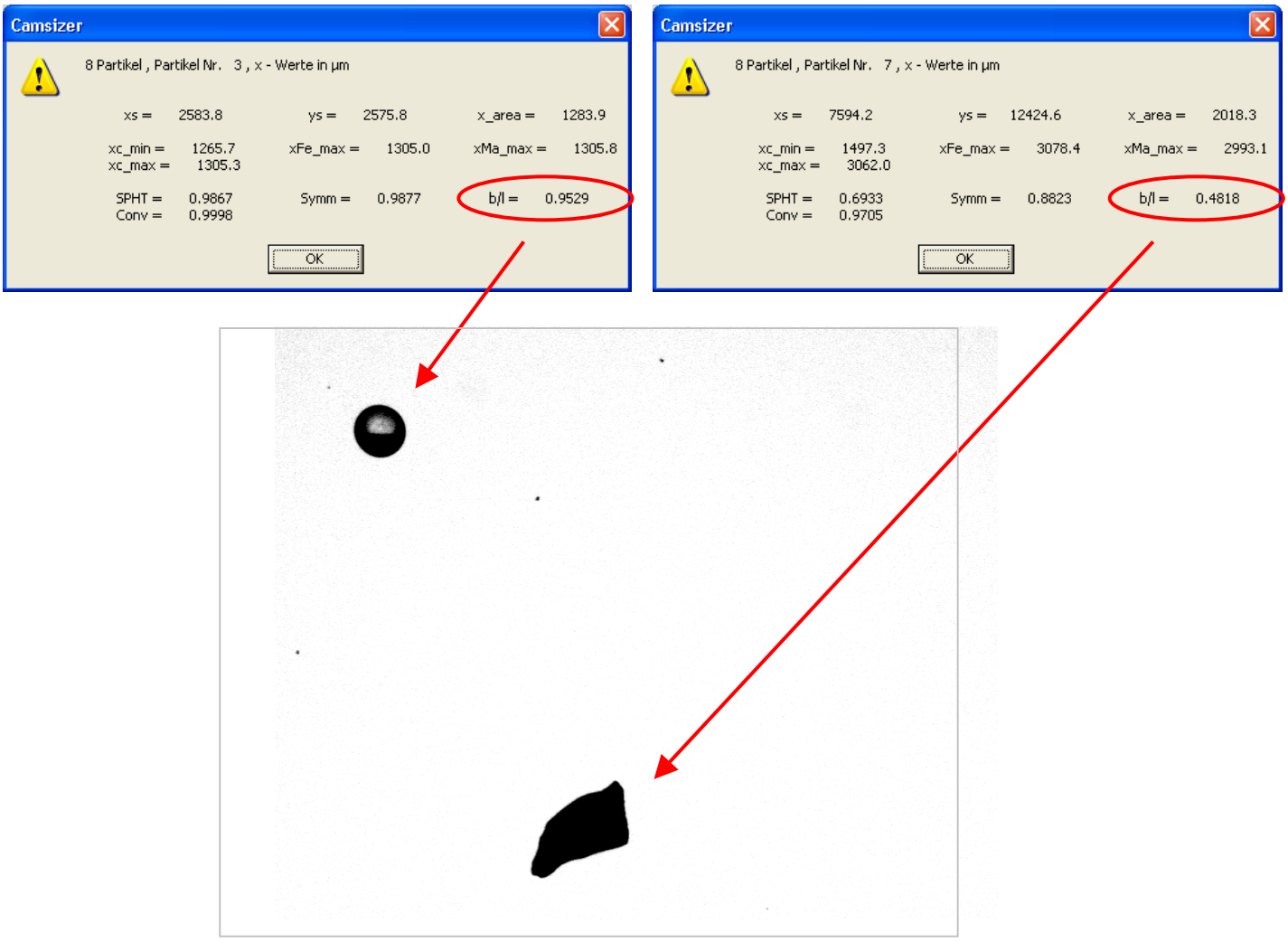
The first step for the determination of the symmetry is to define the centre of the particle (C). Then lines are drawn in every measurement direction from particle edge to edge through the centre. Afterwards the ratio of the resulting segments (r_1 and r_2) is determined. The value for symmetry is calculated from the smallest of these ratios. For highly symmetrical particles like circles, ellipses or squares the value for symmetry nears one. Symmetry is a perfect parameter to define the amount of broken particles within a sample.



Overview Particle Shape Parameters



For the determination of the particle shape Retsch Technology offers the CAMSIZER® that covers a wide dynamic measuring range of 30 µm to 30 mm by dynamic image processing with the patented measurement design with two cameras. These cameras record 60 images per second with 790.000 pixels each. Thus the CAMSIZER® processes more than 45 million measuring points per second. The results are evaluated and displayed in real time.
The throughput can range between few grams to several kilograms per minute, thanks to the fast measurement process, the evaluation of each sample measurement takes approximately 3 – 5 minutes.
A highly interesting feature is the single frame analysis, which displays particle size and shape parameters for each individual particle.
Through optical process control of each particle the user can apply those parameters, which are most important for him in a specific way. For example it is possible to determine threshold values that ensure a uniform product quality.



The measurement of large sample volumes can be automated thanks to the CAMSIZER AutoSampler. This also results in an increased working efficiency.
For continuous quality surveillance the CAMSIZER® is available as an Online-Version that can be customized to the on-site requirements of each user.
Due to these unique features the CAMSIZER® is the best solution for a fast and reliable particle shape analysis.

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