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Application Note

Size and Shape of Cellulose Fibers

AN200

Cellulose is a natural material derived from cell walls of plants. Its fibers are the basis for pulp, which has many diverse uses in industrial products. Different grades of cellulose are used for different applications: paper, construction materials, paper money, hospital supplies, etc. This application note describes how the CAMSIZER XT has been successfully used to characterize cellulose fiber size and shape.

Introduction

The size and shape of the cellulose fibers are important for reasons such as the texture of the final paper surface, the inherent properties of the final product such as tensile strength, and also for production parameters. Thus the quality control of the raw fiber material is an important step, for example for the production of special papers for banknotes. Fibers have traditionally been analysed under a microscope or with laser diffraction particle size analyzers. The microscope method provides an overview over the shape of the particles, but it is a tedious, time consuming process not well suited for measuring a representative large number of fibers in reasonable time. The laser diffraction method is fast and analyses many particles simultaneously, but it does not allow for shape analysis. The CAMSIZER XT provides both: analysis of a high number of particles in a short time, and information about the shape of the fibers.

Dynamic Image Analysis: CAMSIZER XT

Dynamic Image Analysis with the CAMSIZER XT offers a contact free, fast and reproducible alternative (see Figure 1) The instrument is fully automated, which enables every user to achieve the same result in a much shorter time and with less effort than sieving. Up to 40,000 particles can be analyzed per second, thus after 1 to 3 minutes a statistically sufficient amount of sample has been analyzed. The results are perfectly reproducible and identical to the sieve data due to the advanced sieve correlation algorithm in the CAMSIZER software.

The wide dynamic range from 1 µm to 1.5 mm enables the analysis of both fine dust particles and oversized particles in the same sample. Also analyzed is the shape of the particles which can determine agglomeration behavior, or other process dependent parameters.

Figure 1: The CAMSIZER XT

Experimental

Size Analysis

Cellulose fibers were analyzed on the CAMSIZER XT using the X-Jet dry dispersion sampling unit. Powders were dispersed using a 2 bar pressure setting. Measurements typically took 3 minutes.

Fig. 2 shows that size measurement with the CAMSIZER XT provides information on the different dimensions of the particles. The distribution of width diameter, equivalent diameter and length of the fibers are analyzed independently (red, green, and blue curve). The laser diffraction analyzer produces only one curve based on an equivalent spherical diameter.

Thus the CAMSIZER XT allows for a more detailed understanding of the size of the fibers including both the diameter and length.

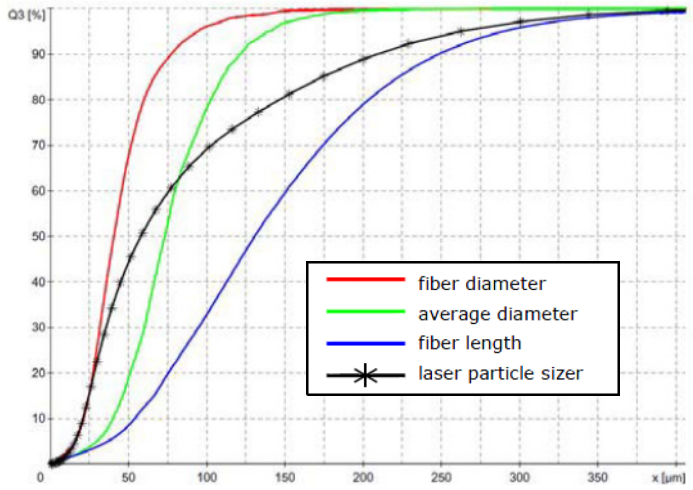

Figure 2: Particle size results with the CAMSIZER XT and a laser diffraction analyzer.

Shape Analysis

Fig. 3 shows the aspect ratio of the fiber samples (diameter to length ratio). A few particles are 5 times longer than the diameter (b/l = 0.2), but almost 50% of the material is less than 2.5 times longer than the diameter (b/l = 0.4), implying a rather compact morphology. The CAMSIZER XT directly analyzes the amount of particles below or above a certain threshold specification.

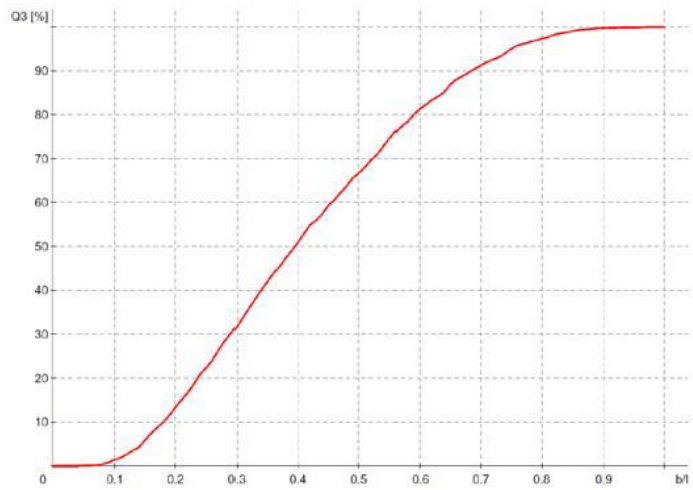

Figure 3: Shape measurement result obtained with the CAMSIZER XT.

The CAMSIZER XT also collects, stores, and presents images of the particles analyzed, allowing for intuitive understanding of particle morphology as seen in Figure 4.

Figure 4: Image of cellulose fibers

Conclusions

Dynamic image analysis by the CAMSIZER XT is an attractive technique for the size and shape analysis of cellulose fibers. The measurements are quick and easy to perform, inspect a statistically valid number of particles, and provide comprehensive size and shape information.