application note

Morphologi G3: Understanding Mineral-based Make-up using Size, Shape and Intensity Measurements

Introduction

Mineral-based powder make-up is an increasingly popular consumer care product where particles of specific size and shape are blended to obtain a product that, in the end, aims to perfectly hide the fact that it is made of discrete particles. The light dispersing properties of the particles are highly influenced by the factors mentioned above and therefore it may be useful in R&D or Quality assurance applications to understand such properties.

In this application note we explore the particles size and shape distribution of three commercially-available mineral-based powders.

Materials and Method

Mineral-based powder make-up was purchased from a large surface retailer. A sample of the powder was retrieved from the top of the container and consequently corresponds to what might be used in a first application from each bottle. We did not explore segregation in these bottles. Two of the products are from the same product line, but aim to achieve different functions. The first product is an ivory-tinted foundation formulated to provide coverage, tint and diffuse light, and the second is a bronzer. Bronzers typically contain coated mica and aim to add a darker reflective finish. Finally, the third product is a mineral veil from a different brand: the veil is a sheer product that aims to absorb oil and minimizes the appearance of pores by diffusing light.

The Morphologi G3S (Figure 1) was used to disperse and measure the dry particles according to a Standard Operating Procedure (SOP) that contained all of the software and hardware settings. For the dispersion a pressure of 0.8 bar was applied for 10 ms and the sample was allowed to settle for 30 seconds. These settings were selected since they generated a dispersion where most particles were individually separated, with very few aggregates, without causing particle breakage. The sample was analyzed with the 10x magnification and more than 10,000 particle images were collected per product with a total data acquisition time of approximately 15 minutes each.

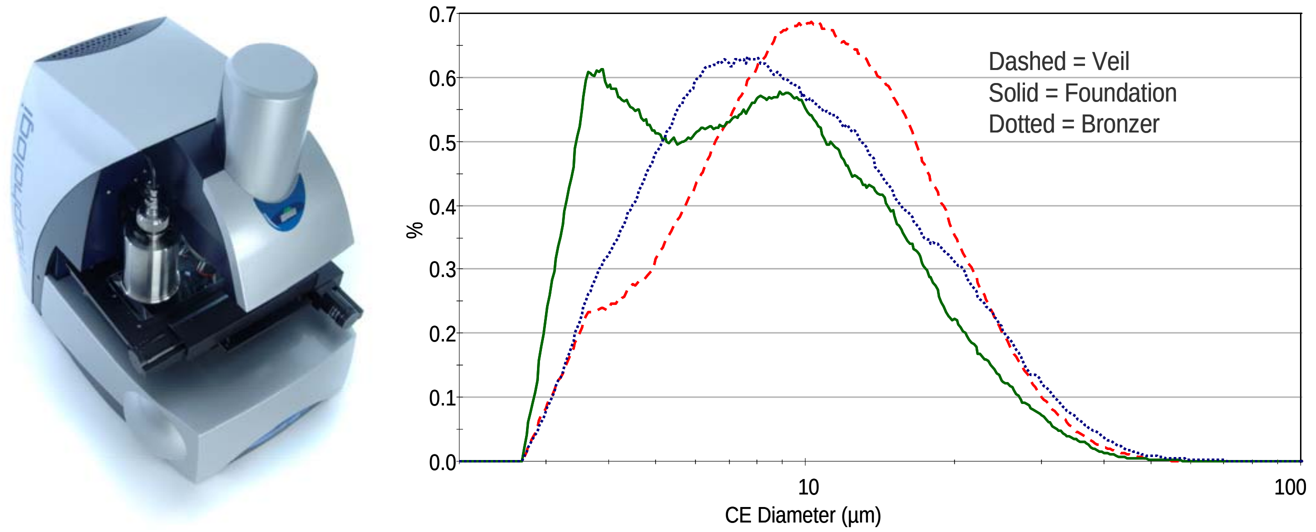

Figure 1: The Morphologi G3S and the overlay of the number-based CED distributions of three mineral-based make-up samples

Results and Discussion

Particle size in the powder affects the final make up appearance where extremes lead to a poor finish. When the particles are too large a powdery look is observed and when the particles are too small there is an insufficient masking effect.

Figure 1 shows the overlay of the number-based particle size distribution of the three samples in terms of Circular Equivalent Diameter (CED). The CED was selected as the measurement of size because it is convenient for comparison with traditional particle sizing techniques, such as laser diffraction, which assumes spherical particles.

For this application a number-based distribution better represents particle size since smaller particles are important; indeed each particle, regardless of its size, has the same contribution to the distribution in a number-based approach.

Figure 1 shows there is a clear bimodal size distribution in the foundation product and the veil is generally made of larger particles.

Images of every particle analyzed are retained by the system and can be used to visually inspect the products, thereby providing a qualitative analysis of the sample. Figure 2 shows some example images of large and medium sized particles from the three products. In the veil product, the largest particle is obviously an aggregate of plates, while the third largest is an aggregate of dark pseudo-spherical particles. The two other products do not show such aggregates among their largest particles. In all cases, there are plate-like and pseudo spherical-like particles in the medium size group. Similar particle size, shape and intensity (opacity) are observed in this table for the three samples and a statistical analysis of a larger number of particles is necessary to understand the bulk differences between the samples.

The ability to measure and compare large numbers of particles in a powder sample is the strength of automated image analysis; by acquiring images

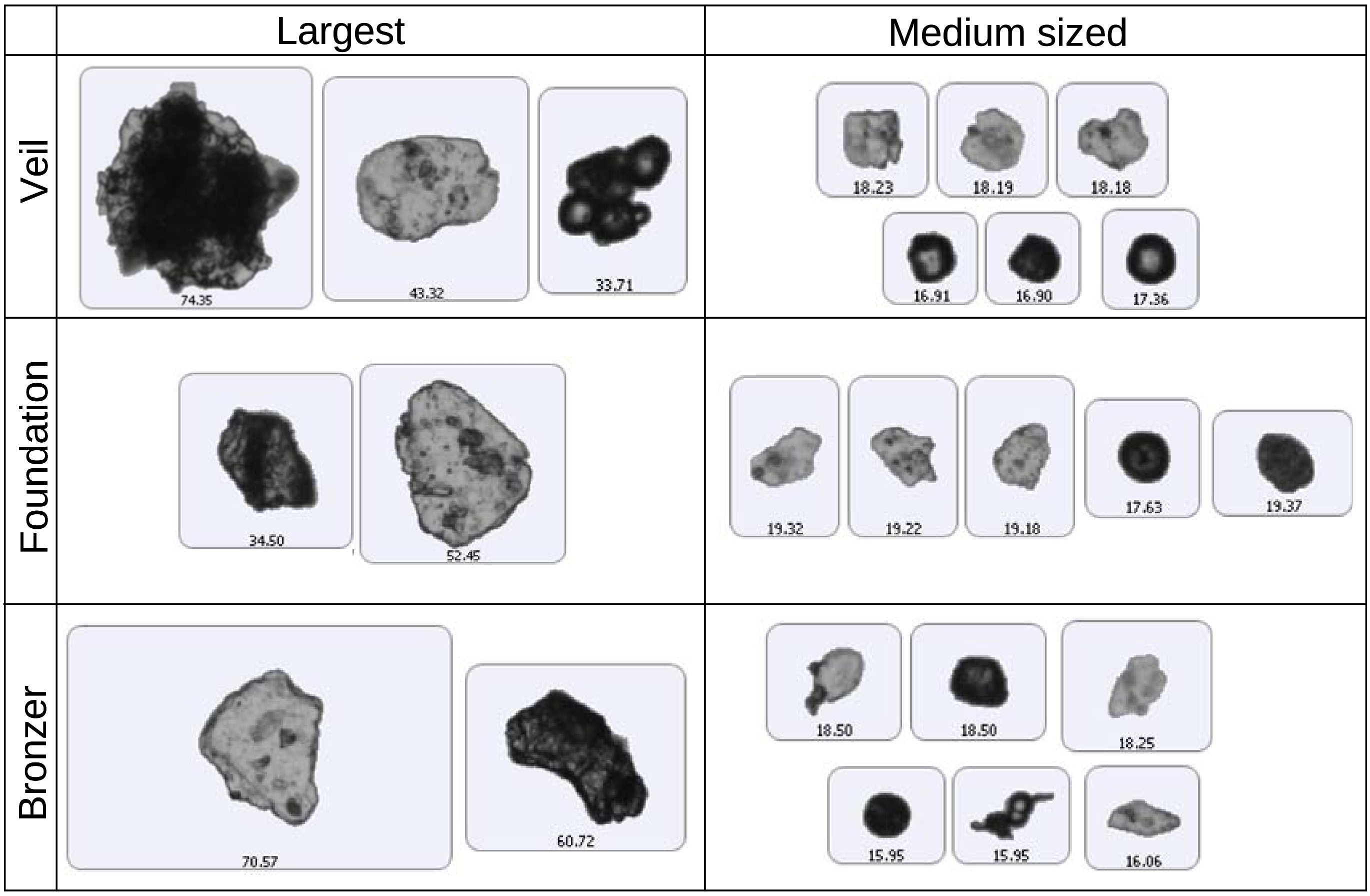

Figure 2: Images of particles from the three samples

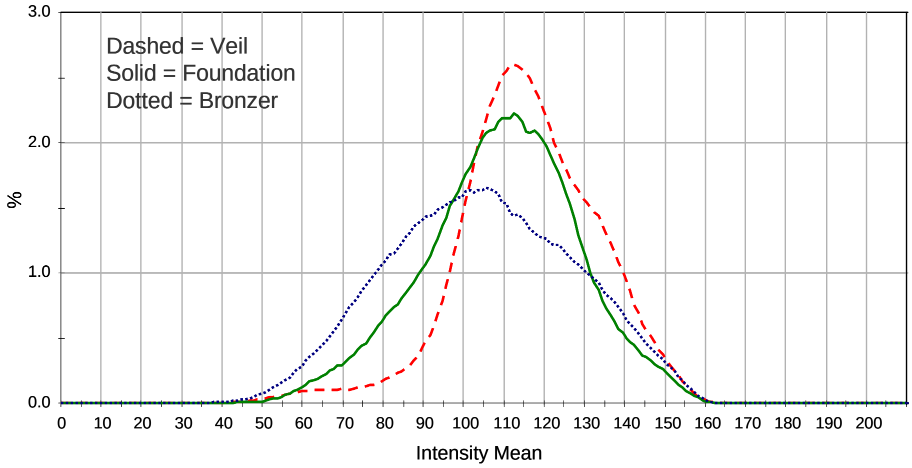

Figure 3: Intensity distribution for the three mineral make-up samples.

from thousands to tens of thousands of particles, it is possible to obtain a more reliable characterization than is typically obtained with manual microscopy, which is labor intensive and may be highly influenced by the operator's skills.

Particle shape is very important in make-up because of its effect on light reflection. For example, plate-like crystals create a pearlescent effect where the size of the plates determines the level of sparkle: Small plates give a more opaque smooth finish, while larger plates add a brilliant spark.

The mean intensity in a diascopic measurement is an indication of the transparency of the particles. Considering the finish requirements of the three samples, it is not surprising that very different mean intensity profiles were measured. Figure 3 shows a overlay of the mean intensity distributions of the particles in the three samples. These distributions correspond well with the product properties, where the particles in the veil are more transparent and the particles in the bronzer are the darkest.

It is also possible to use multiple parameters to compare samples and provide classification statistics. It is important to select characteristics that are related to the performance of the product and for this case, we selected the CED and the mean intensity.

Classes were set up as follows:

Large Lighter: CED>10µm and Intensity mean >130 grey scale.

Large Darker: CED>10µm and Intensity mean <130 grey scale.

Small Particles: CED<10 µm.

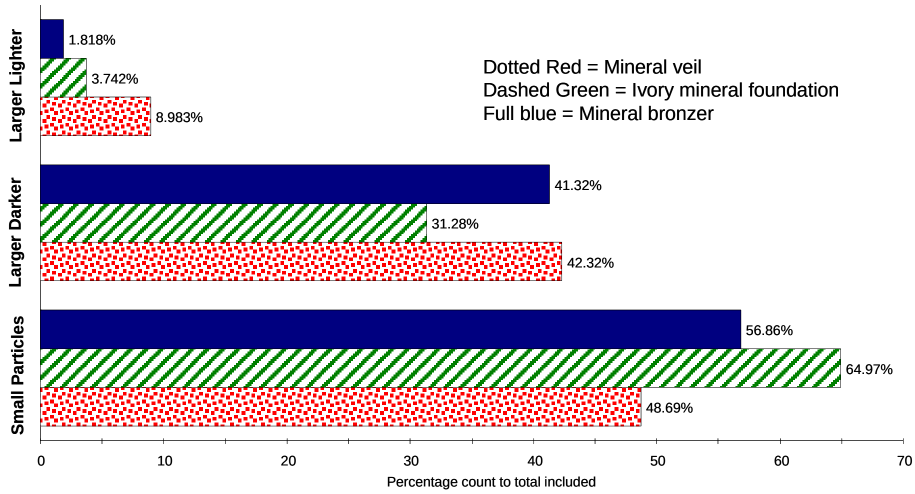

Figure 4: bar chart showing the results of the Classification

Figure 4 shows the proportions of particles in each of the three classes. As expected, the veil product contains a greater proportion of large lighter particles, which are typically used to diffuse light while not imparting any pigmentation. The bronzer shows a different trend, with a greater proportion of dark particles in the large size fraction, but also more small particles than the veil, probably to add spark to the bronzed look it is meant to achieve.

Obviously, this type of analysis is useful in Quality Assurance applications, where understanding the proportions of various types of particles is key to ensuring the desired functional properties.

Conclusion

Particle imaging is a discipline that was once labor-intensive and highly subjective because it was performed manually. The development of automated particle imaging instruments equipped with integrated computer-controlled dispersion, advanced image processing and statistical analysis tools, such as the Morphologi G3S, have taken this informative technique to a new level where the quantitative data can be used in formulation development, for quality control and for reverse engineering. We focused this application note on characteristics of the larger particles, but higher magnification measurements would provide similar information about the smaller particles.

The Morphologi G3S instrument is flexible and allows for a very broad range of measurements to be made, which can be designed to verify properties of specific interest.

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