HORIBA Scientific

partica LA-960V2

Application Note

Calcium Carbonate Particle Sizing for Paint and Coating Applications

AN241

Namarata Jain[1], Yina Bo[2], Tetsuya Mori[2]
[1]HORIBA India Private Limited, [2]HORIBA, Ltd.

Introduction

Calcium carbonate ($CaCO_3$) is one of the most abundant minerals on the Earth with a large array of industrial applications. It is extensively used by the aqueous paint and coating industries as an extender and as a pigment (due to its special white colour), typically in the range of 20-60%. Particle size control of calcium carbonate within formulations plays a vital role in various coating properties important to the paint chemists such as viscosity, dispersion stability, opacity, and tinting strength. A pigment obtains, for example, its maximum colour effect only in a narrow particle size range below 1 to 2 microns. Therefore, understanding particle size distribution of calcium carbonates becomes one of the foremost parameters to be examined. In this study, the particle size distribution of the two different grades of calcium carbonate was investigated using HORIBA Partica LA-960V2 Laser Scattering Particle Size Distribution Analyzer.

Background

Advancements of analytical instrumentations and characterization tools have been subject to significant developments in science and technology. Laser diffraction/scattering technology has emerged as one of the most important and effective techniques in the world of particle size analysis to characterize and quantify micron size particles with high efficiency. Partica LA-960V2 (Figure 1) with a dynamic size range from tens of nanometers to millimeters allows rapid analysis in less than a minute with high accuracy. The system reports volume-based size distribution along with wide range of additional parameters. For example, calcium carbonates are often specified on the 10th percentile (Dv10) that helps to detect and quantify the fine particles in the distribution. Whereas the 90th percentile (Dv90) helps in detecting the coarse particles in the distribution.

Figure 1. (Left) HORIBA Partica LA-960V2 Laser Scattering Particle Size Distribution Analyzer. (Right) Image of paint.

Calcium carbonates are available in a wide size range and different surface coatings to support the range of functionality in diverse industrial applications. The most common method of coating is using stearic acid that comes from the family of fatty acids. Natural (uncoated) calcium carbonate is hydrophilic, meaning that it tends to attract water. The high surface energy of the particles causes a lot of friction that leads to agglomeration or aggregation of fine particles. Coating of calcium carbonate provides superior filler product to the paint industry by allowing to reduce the friction and make the mineral hydrophobic. This process helps to improve the dispersibility, dispensability, processability, and stability of the finished product. Coating of the raw material during synthesis also helps in achieving better control over the resultant particle size and one should expect a slight increase in the primary particle post coating. However, big variation in particle size distribution of coated and uncoated material might indicate agglomeration or flocculation of particles during production. The high performance of the Partica LA-960V2 allows the particle size of calcium carbonate to be tracked during the production processes as well as for quality control of the end products.

Sample preparation

Sample preparation step is indispensable before any instrumental analysis. The sample must be a representative of a defined whole (e.g., batch, production lot), and the method of sampling depends on the size and the nature of the product. Most of the errors and time spent during an analysis depend on the sample preparation. Any improvements in this essential process ensures a significant effect on shortening the analysis time and influencing the reliability, precision, and accuracy of the produced data.

Since liquid dispersions are known to provide more control over the dispersion state for the finest grades producing reproducible results, wet measurement method of laser diffraction system was used to study particle size distribution of calcium carbonate. Because calcium carbonate is hydrophilic, uncoated material can be easily dispersed in water and additives such as sodium hexametaphosphate (SHMP) are used to stabilize the dispersion by preventing the flocculation of calcium carbonate particles during analysis. On the other hand, coated particles require the use of organic solvents as dispersion medium because they are hydrophobic.

In this measurement, the uncoated grades of calcium carbonate were dispersed in water with an optimized concentration of 0.5% SHMP, and the two coated samples were dispersed in iso-propanol (IPA).

Result

The particle size distribution profile for the two different grades of calcium carbonate is shown in Figure 2. Bimodal distribution observed in grade A post coating clearly indicates partial coating of the material and hence is not yet ideal to be used for any industrial application. However, grade B gives narrow monomodal distribution with very high repeatability and reproducibility post processing, hence confirming the product stability with an efficient coating. This further ensures the applicability of the produced material as a filler in paint and coating industry.

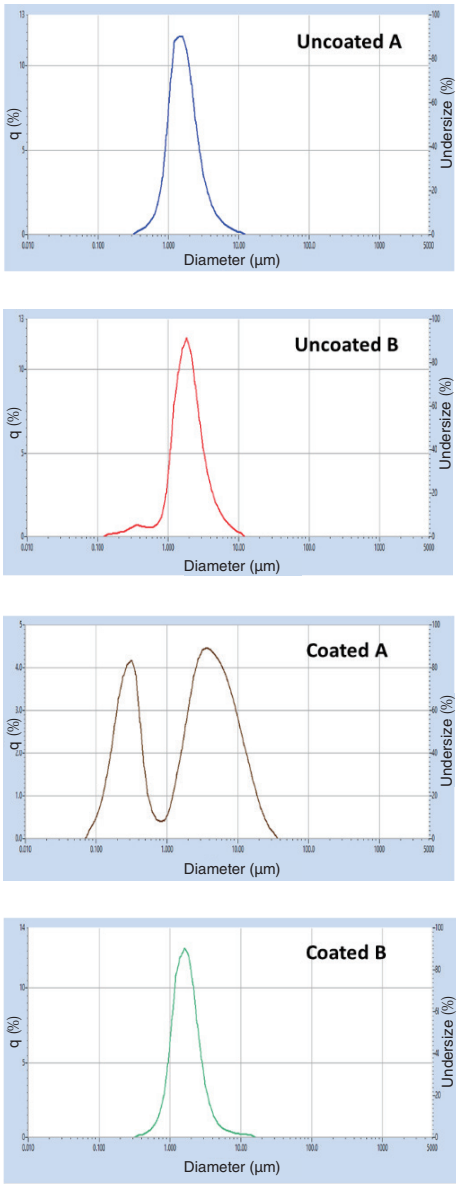

Figure 2. Particle size distribution profiles for different grades of calcium carbonate samples measured in liquid (wet) dispersion.

Table 1 provides further details on the data derived using the distribution profile for each sample. The system reports the data in form of Dv10, Dv50 and Dv90 that shows 10%, 50% and 90% percent of particles volume respectively are below the reported size. Moreover, the technology supports quantification of required particle size grades. For instance, the percentile of finer grade material (below 1 µm and 2 µm) is reported as %V. Partial coating of grade A results in agglomeration of the uncoated material as D90 increases significantly from 2.27 to 10.39 µm. This change in size from coated to uncoated material is less significant in case of grade B that is expected from an efficient coating process.

Table 1. Particle size parameters derived for four grades of calcium carbonate

S.NO	Sample	Grade	D10 (µm)	D50 (µm)	D90 (µm)	%V<1 µm	%V<2 µm
1	A	Uncoated	0.661	1.271	2.274	29.77	84.00
2	B	Uncoated	0.427	1.497	2.752	26.89	72.35
3	C	Coated	0.213	2.640	10.388	34.61	42.68
4	D	Coated	0.977	1.649	2.996	10.81	67.31

Conclusion

HORIBA Partica LA-960V2 can be efficiently used among paint and coating industry for the particle size analysis of different grades and sizes of calcium carbonates due to its wide size range, high repeatability and reproducibility of the obtained data, flexible dispersion options, and rapid measurement speed. Detection and identification of finer particles in various grades of calcium carbonate ensures the best results for the produced colours in the paint and coating materials. This further ensures the importance of particle size distribution characterization in this industry using laser diffraction/scattering technology.