Development of New Method to Measure Particle Size Using Infrared-Attenuated Total Reflection Combined with Sedimentation Phenomena Applicable for Size Measurement of Each Species in Chemically-Different Kinds of Particles

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1. Introduction

Particle size measurements are carried out in various fields of scientific studies and industries such as colloid processes and medicals. Generally, particle size is measured by sedimentation, light scattering and diffraction, electron microscopy, etc. Although these techniques have several advantages, they also have some drawbacks. A new method for particle size measurement is proposed using IR-ATR technique and sedimentation phenomenon. The former is used for the particle detection and the latter is used for the size measurement. The size measurement method using sedimentation phenomenon is a traditional one, but its combination with IR-ATR technique produces high ability for the size distribution analysis.

2. Results and Discussion

The SEM image analyses for commercially available SiO_2 $\Phi0.8$, $\Phi1.5$, and $\Phi5.0$ μm samples gave sizes of about 0.6, 1.3, and 4.0 μm on average, which were closer to 0.8, 1.5 μm and less than 1 μm for $\Phi5.0$ μm, but the optical microscope image analysis for commercially available $\Phi5.0$ μm sample gave smaller size of $\Phi3.5$ μm on average than 5.0 μm. For SiC particles an average of 1.7 μm for $\Phi3.0$ μm commercially available samples and for Al_2O_3 an average of 0.6 μm for $\Phi1.0$ μm commercial samples.

For mono dispersed system, each particle size ($\Phi0.8$, $\Phi1.5$ and $\Phi5.0$μm) of SiO_2 particles, SiC of $\Phi3.0$μm and Al_2O_3 of $\Phi1.0$μm show different time dependences of relative intensities. In polydispersed system, each amount of component was successfully determined within some experimental error using fitting technique.

Chemically-different kinds of particle can be analyzed quantitatively using this new method.

3. Conclusions

IR-ATR intensity was shown to behave against time in the same manner as expected from the simulation based on the theory constructed by us in the mono-size-dispersed particles system and we were able to determine the amount of each component in the two-size-dispersed particles system within some experimental errors. The energy, which was linear to the IR-ATR absorption, was calculated against time of sedimentation to give simulation of IR-ATR experimental results for mono-size-dispersed particles. The theory constructed here was applied to the size-distribution analyses of commercially available $\Phi0.8$, $\Phi1.5$, and $\Phi5.0$ μm SiO_2 particles samples, $\Phi1.0$ μm Al_2O_3 and $\Phi3.0$ μm SiC particle samples. The superposed simulations based on the equation obtained successfully reproduced the time dependences of areas of IR-ATR absorptions of these samples using fitting technique. The size-distributions obtained from the reproduction procedures, $\Phi0.70$ $\pm_{0.06}^{0.08}$, $\Phi1.4$ $\pm_{0.13}^{0.20}$, and $\Phi4.1$ $\pm_{1.5}^{2.0}$ μm, agreed well with those obtained from image analyses.

The new methods and the theory constructed by us were successfully applied to the particle-size distribution analysis. Fitting technique for data analysis gave size distribution close to SEM analysis. Even though only 1 trial has been made to 3-component mixture, result shows that it is possible to use our method to more than 2-component mixture. Therefore this new method is applicable in size measurement of each species in chemically-different kinds of particle.