EFFECT OF MECHANICAL DRY COATING ON THE MODIFICATION OF THE SURFACE PROPERTIES OF SILICA GEL POWDER: SURFACE MORPHOLOGY, FLOWABILITY AND WETTABILITY

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Abstract

Dry particle coating to change the surface properties and/or functionality of powders is very important to many industries. Typical applications include but are not limited to flowability, solubility, dispersibility, Wettability (hydrophilic/hydrophobic properties), electric, electrostatic, magnetic, optical, color, flavor, shape, etc. Particles with relatively large particle size (host particles, 1-500 µm) can be mechanically coated with fine particles (guest particles, 0.1-50 µm) in order to create new functionality or to improve their initial characteristics.
In this paper we describe the experimental investigation of an application of dry coating technique to change the surface properties of silica gel particles (d_{50} = 55 µm) coated with different mass ratio of magnesium stearate (MgSt; d_{50} = 4.6 µm): 1%, 5% and 15%. The dry coating experiments were performed by using a high-speed dry impact blending coater. This device, called "the Hybridizer", is manufactured by Nara Machinery of Japan.
The uncoated and coated silica gel particles were observed by environmental scanning electron microscopy (ESEM). The images showed that a uniform coating was obtained after treatment in the Hybridizer. Greater MgSt coverage was observed on the surface of silica gel as the MgSt mass ratio is increased to 15%. In addition, Atomic force microscopy (AFM) analysis revealed how this coating process allows obtaining a discrete but uniform dispersion of the MgSt particles. By this technique, the thickness of MgSt layer deposited on the surface of silica gel particles was estimated of approximately 5 nm. AFM studies were carried out with a scanning probe microscope Multimode Nanoscope IIIA (Digital Instruments/Veeco Metrology Group). All measurement of the surface morphology of uncoated und coated silica gel particles were conducted at ambient conditions in tapping mode with phosphorus (n) doped Si probes (stiffness 3 N / m). Height and phase images were simultaneously recorded. The Picoforce option has been used in contact mode to measure the adhesion force between the uncoated and coated silica gel particles and the Silicon Nitride probe (stiffness 0,32 N / m). The results showed stronger adhesion between the coated silica gel particles and the probe (10 – 150 nN) whereas for the uncoated silica gel particles, the adhesion forces were between 10 and 20 nN.
The flowability of the different samples obtained with Hybridizer has been characterized by measurements of the tapped and aerated densities. It has been shown that the flowability of silica gel treated alone and with MgSt in Hybridizer was not significantly affected and remains good. The wettability of silica gel was determined by measurements of the contact angle between the water drop and the powder bed prepared for each sample. The results obtained have shown that the coating of silica gel powder by hydrophobic magnesium stearate in the Hybridizer can improve its hydrophobic properties.

Keys words: dry coating, Hybridizer, AFM, adhesion force, Wettability, flowability.