used, there arises a new problem that the transfer passage must be replaced frequently because the transferred powder comes into contact with the transfer passage made of the conductive material to abrade the inner wall of the transfer passage. Further, there is also known a method of electrical neutralization by blowing oppositely charged ions to the generated electrical charges; however, the effect is low because even if ions having opposite charges are fed from an inlet of a long and thin passage such as the powder transfer passage, the charge of ions disappear on the way and do not spread over the entire transfer passage because the lives of the ions are short.

[0008]

On the other hand, in the field of handling powder, basically the inclusion of water in the powder is avoided as much as possible, and particularly in the field of gas transfer type powder quantitative feeding, it is common to dry not only the powder but also the carrier gas. This is because a high water content causes liquid cross-linking between the particles that are the cause of inducing adhesion in between the particles which impairs the fluidity of the powder. However, although in the case of a powder kind that is dependent of powder fluidity, i.e. powder with good fluidity, reducing the liquid cross-linking by eliminating the water content contributes to its quantitative/stable feeding, in the case of powder such as fine powder with low fluidity, there is a need of a solution for the problem induced by static electricity because an adverse effect is rather large due to static electricity generated in a dry state.

[0009]

Therefore, in order to quantitatively transfer and feed the fine powder by the carrier gas, there is a demand for a method for removing static electricity which is a cause of powder adhesion to the

transfer passage and a system used for such a method.

[0010]

Embodiments of the present invention provide a gas transfer type fine powder quantitative feeding method and system capable of quantitatively and stably transferring and feeding powder, in particular, fine powder having an extremely light mass. Embodiments of the present invention also provide a carrier gas humidifying unit that can be used in such method and system.

[0011]

According to a first aspect of the present invention, there is provided a gas transfer type fine powder quantitative feeding system including: a humidifying chamber for humidifying a carrier gas; and a gas transfer type fine powder quantitative feeder that quantitatively feeds a mixed fluid of the carrier gas and fine powder to a fine powder using device by feed of the carrier gas from the humidifying chamber, wherein the gas transfer type fine powder quantitative feeder includes: a fine powder storage container that stores the fine powder; a housing that stores the fine powder storage container in a gas-tight manner; a feed port that feeds the carrier gas to the housing; a flow rate adjustment mechanism that adjusts a feed amount of the carrier gas to the housing; a feed nozzle that feeds the fine powder from the fine powder storage container to the fine powder using device entrained with the carrier gas; a position detection sensor for detecting a relative position between the feed nozzle and the fine powder surface; a driving part that moves the feed nozzle in an up and down direction; and a humidity measuring sensor for measuring humidity in the housing; and wherein the humidifying chamber includes: a water tank that stores liquid for humidifying the carrier gas; an ultrasonic vibration mechanism for atomizing the liquid; and a humidity control

mechanism for controlling humidity in the housing in conjunction with the humidity measuring sensor.

[0012]

[0013]

In the above aspect of the gas transfer type fine powder quantitative feeding method of the present invention, the water content of the carrier gas is preferably adjusted so that scattering time τ of static electricity generated in the mixed fluid is 0 to 10 seconds.

[0014]

In the above aspect of the gas transfer type fine powder quantitative feeding method of the present invention, the fine powder preferably has an average particle size of 10 μm or less.

[0015]

According to a second aspect of the present invention, there is provided a gas transfer type fine powder quantitative feeding system including: a humidifying chamber for humidifying a carrier gas; and a gas transfer type fine powder quantitative feeder that quantitatively feeds a mixed fluid of the carrier gas and fine powder to a fine powder using device by feed of the carrier gas from the humidifying chamber, wherein the gas transfer type fine powder quantitative feeder includes: a fine powder storage container that stores the fine powder; a housing that stores the fine powder storage container in a gas-tight manner; a feed port that feeds the carrier gas to the housing; a flow rate adjustment mechanism that adjusts a feed amount of the carrier gas to the housing; a feed nozzle that feeds the fine powder from the fine powder storage container to the fine powder using device entrained with the carrier gas; a position detection sensor for detecting a relative position between the feed nozzle and the fine powder surface;

a driving part that moves the feed nozzle in an up and down direction; and a humidity measuring sensor for measuring humidity in the housing; and wherein the humidifying chamber includes: a water tank that stores liquid for humidifying the carrier gas; an ultrasonic vibration mechanism for atomizing the liquid; and a humidity control mechanism for controlling humidity in the housing in conjunction with the humidity measuring sensor.[0016]

In the above aspect of the gas transfer type fine powder quantitative feeding system of the present invention, the humidity control mechanism adjusts the water content of the carrier gas so as to reduce generation of static electricity in the mixed fluid.

[0017]

In the above aspect of the gas transfer type fine powder quantitative feeding system of the present invention, the average particle size of the fine powder is preferably 10 μm or less.

[0018]

According to a third aspect of the present invention, there is provided carrier gas humidifying unit for use in the gas transfer type fine powder quantitative feeding system according to the second aspect, including: a humidity measuring sensor for measuring humidity in the housing; a humidifying chamber for humidifying the carrier gas; a humidifying carrier gas feed nozzle for feeding the humidified carrier gas to the device; wherein the humidifying chamber includes: a water tank that stores liquid for humidifying the carrier gas; an ultrasonic vibration mechanism for atomizing the liquid; and a humidity control mechanism for controlling humidity in the housing in conjunction with the humidity measuring sensor.

[0019]

According to embodiments of the present invention, it is

possible to quantitatively and stably transfer and fine powder with extremely light mass to a device using the fine powder.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a conceptual diagram of a method for quantitatively feeding a fine powder according to the present invention.

FIG. 2 is a conceptual diagram of fine powder deposition in a tube for powder transfer.

FIG. 3 is a figure showing a fine powder feeder according to one embodiment of the present invention.

FIG. 4 is a figure showing a part of a feed nozzle according to one embodiment of the present invention.

FIG. 5 is a figure showing a configuration of a gripping portion attached to the vicinity of a tip of a rod according to one embodiment of the present invention.

FIG. 6 is a diagram showing a fine powder feed system according to one embodiment of the present invention.

FIG. 7 is a figure showing a humidifying unit according to one embodiment of the present invention.

FIG. 8 is a relationship diagram between τ and absolute humidity in a test example of the present invention.

FIG. 9 is a relationship diagram between τ and blockage in a tube in a test example of the present invention.

FIG. 10 shows a result of a powder feed test in a test example of the present invention.

FIG. 11 is a test result of the relationship between the absolute humidity and the feedable time of fine powder in the test example of the present invention.