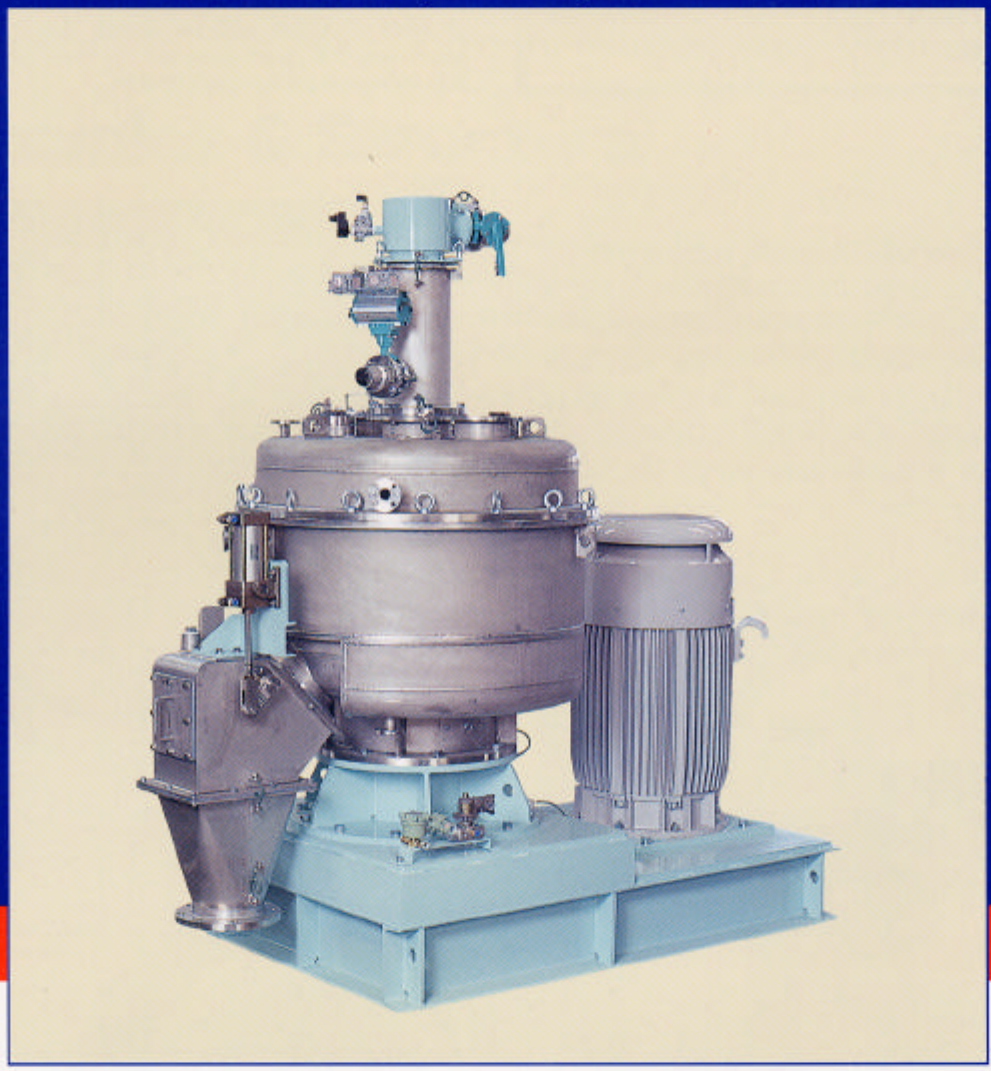
HOSOKAWA MICRON

Mechano Fusion® System AMS

Designed for particle-to-particle fusion in order to enhance particle performance



Process Technologies for Tomorrow

HOSOKAWA MICRON CORPORATION

contents

The Mechano Fusion System explores possibilities for new materials.

Mechano Fusion refers to the process by which mechanical energy is applied to several

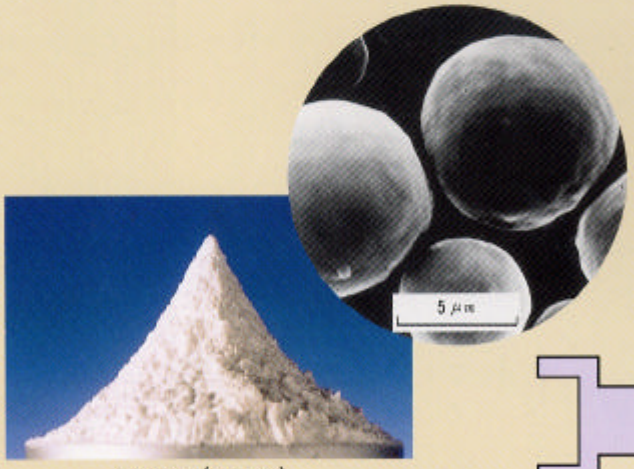
different types of particles to induce a mechano-chemical reaction, thereby creating new materials. Since there is an infinite variety of possible particle combinations, various forms of particle designs and processing technology have now become a reality in a broad range of fields. Coupled with the above, Mechano Fusion technology has been employed to yield new materials with enhanced particle performance.

Application for cosmetics

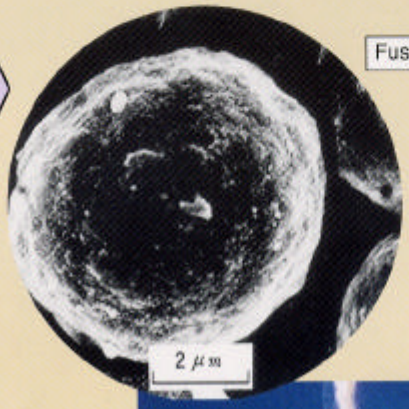
Mechano Fusion can fuse nano-order particles onto the surfaces of particles as fine as several microns in both a quick and simple manner. For example, combining titanium oxide particles (with a BET diameter of 15nm) on the surface of PMMA particles (with a mean diameter of 5μm) produces a product that exhibits not only entirely different properties from those of the component particles, but also fluidity similar to liquid.

Ti mapped photograph

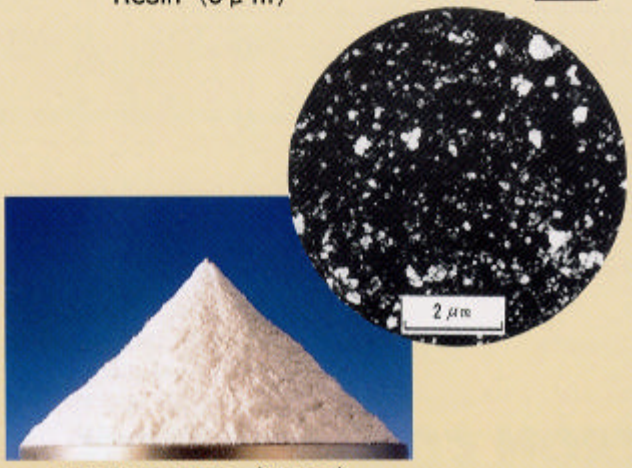
Particle cross section



Resin (5μm)



Fused particle



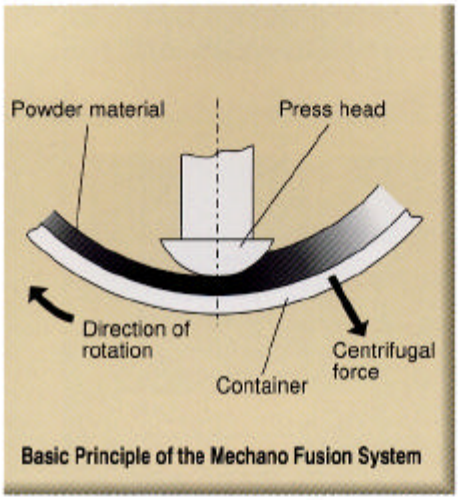
Titanium oxide (15nm)

Main Features

The Mechano Fusion System can:

1. produce composite particles, control particle shapes (making them spherical or flat) and combine particles in rigorous precision.
2. eliminate the need for pre-mixing particles during particle performance improvement processes (any addition of a pre-mixing process achieves a further cut in processing time.)
3. fuse higher volumes of particles while providing the same level of Mechano Fusion effect as the previous model.
4. allow for ease of loading and unloading powder materials (it is even possible to unload the entire amount of material.)
5. control product temperature by the use of a water-cooled jacket that is provided on the casing.
6. can substantially save space due to its reduced size compared with the previous version.

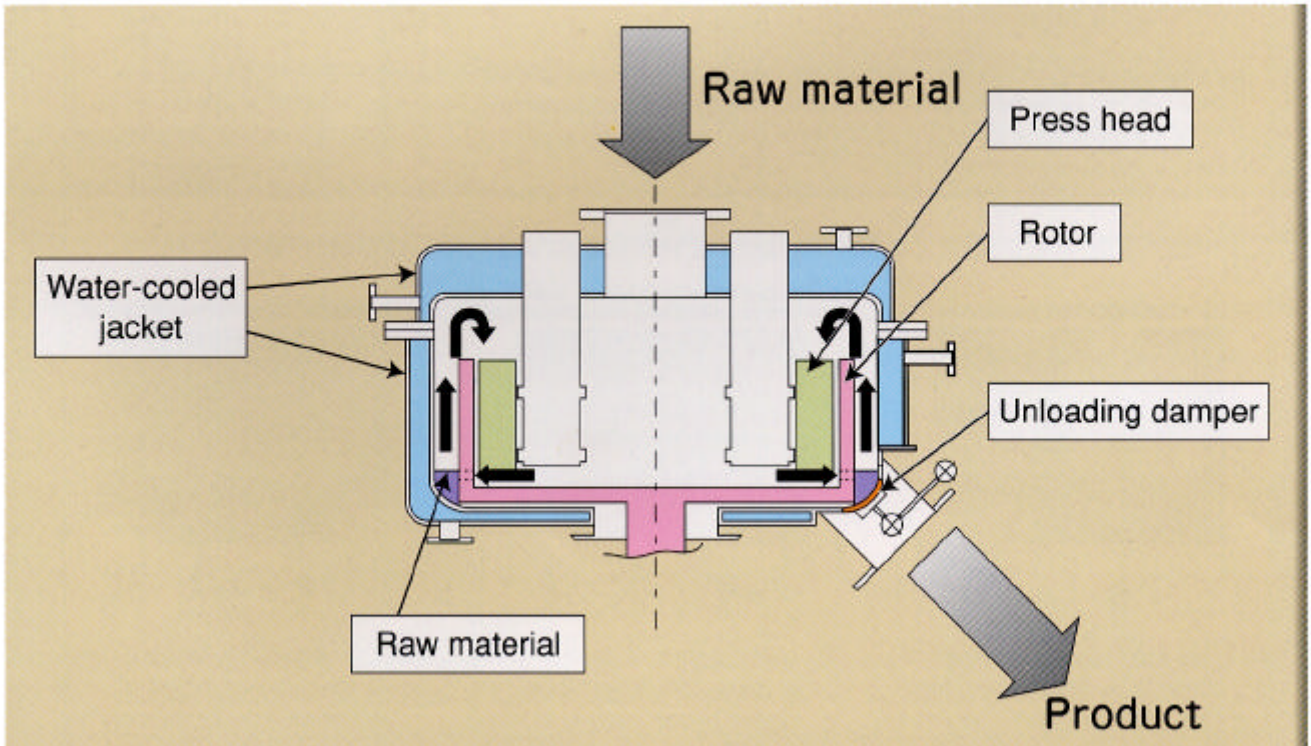
Principles & Structure



Basic Principle of the Mechano Fusion System

The basic operating principle of the Mechano Fusion System is shown in the left-hand diagram. The powder materials in the rotary container are subject to a centrifugal force and are securely pressed against the wall. The materials undergo strong compression and shearing forces when they are trapped between the wall and the press head with a different curvature.

In the new Mechano Fusion System (AMS Model), as indicated in the drawing below, the powder materials are delivered outside through slits on the rotary rotor walls. They are then carried up above the rotors by the rotor-mounted circulating blades. Subsequently, the materials return again to the rotors where they receive strong forces from the press head. This cycle of both three-dimensional circulation and effective compression/shearing of the powder materials are repeated at high speeds, thereby forming them into a composite material.

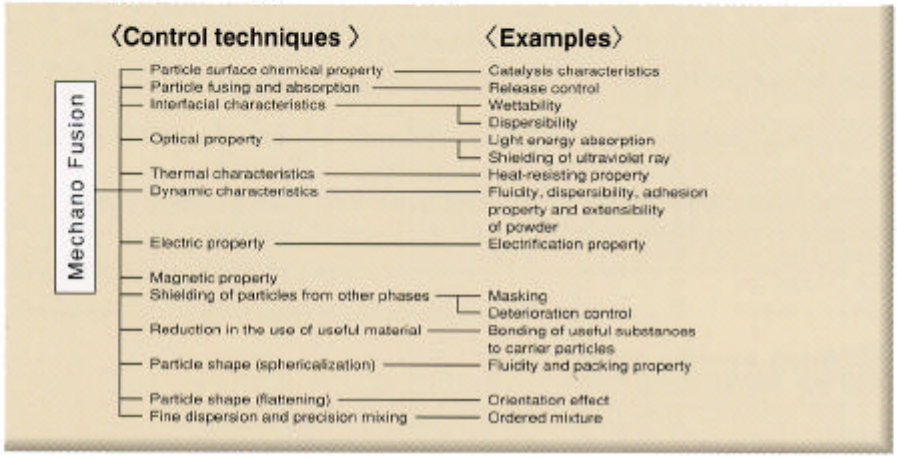


Schematic drawing of the circulation-type Mechano Fusion System (AMS Model),

Applications

The Mechano Fusion System is capable of both preparing particles with enhanced performance and mechanically processing large quantities of new material particles. The processes employed include:

* combining particles of organic and inorganic substances, metals, ceramics and other similar materials;
* modifying the surface properties of these particles;
* controlling particle forms; and
* distributing and blending particles in a fine, precise manner.

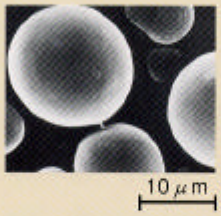


Typical applications of the Mechano Fusion System include:

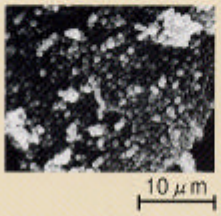
- Catalysts
- Ceramic parts
- Electrical parts
- Magnets
- Toner
- Electronic parts
- Cosmetics
- Medicine
- Pigments
- Li-ion rechargeable battery
- Ni-MH rechargeable battery
- Fuel batteries
- Biochemical applications
- Cement materials
- Powder metallurgy
- Thermet materials

1. Combination of particles into a composite

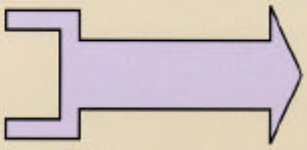
(1—1) Resin electrification control (resin to resin fusion)

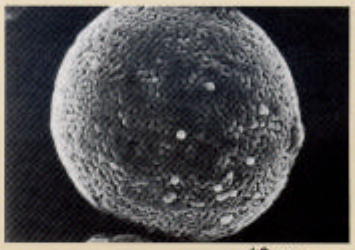


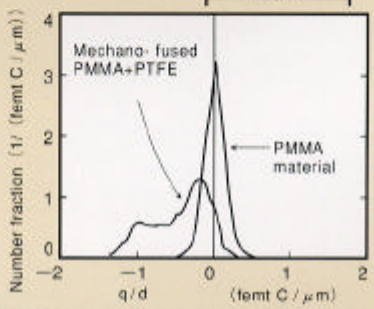
PMMA particles



Ultra-fine fluorocarbon resin particles



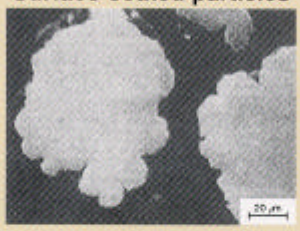




PMMA particles, with poor electrification quality, can be successfully modified into particles that have strong negative by charging properties. This is accomplished by fusing the ultra-fine particles of the fluorocarbon resin to the surfaces of the PMMA.

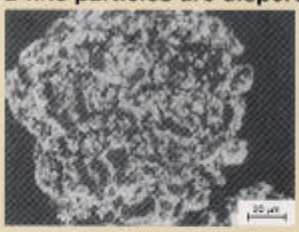
(1—2) Lightweight heat-resistant materials[※1)] (metal to metal fusion)

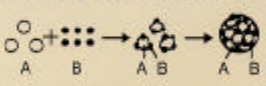
Surface-coated particles



(1) This microscopic photograph shows a surface-coated structure resulting from mechano fused nickel (bright) and aluminum (dark).

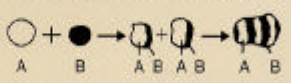
Particles in which other types of ultra-fine particles are dispersed





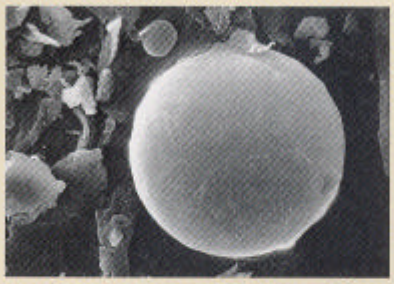
(2) Shown above is an aggregate structure that is produced by rotating micron-sized Ni-Al composite powder materials at high speeds for mechano fusing.

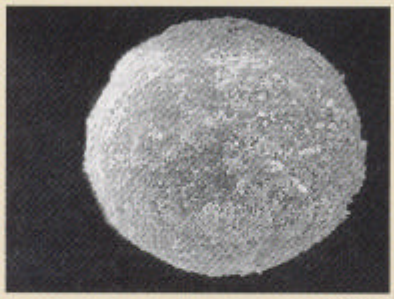
Lamella structure particles



(3) This photograph depicts a lamella structure composed of Ni-Al composite powder materials that are mechano fused using a zirconia medium.

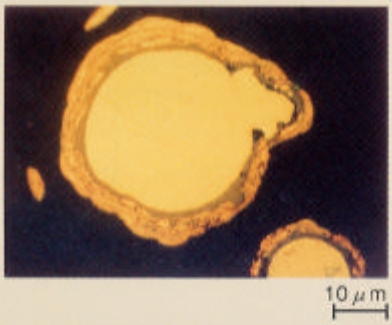
(1—3) Application for electrical and electronic parts (metal to ceramics fusion)



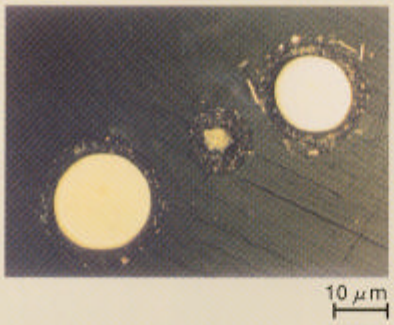


Ultra-fine ceramic particles are fused around the surfaces of the metal particles. This process yields a new material that combines the electromagnetic properties of the metal material with the electrical insulation qualities of the ceramics.

(1—4) Application for high-performance structural materials[※2] (metal to ceramic polyphase composite particles)



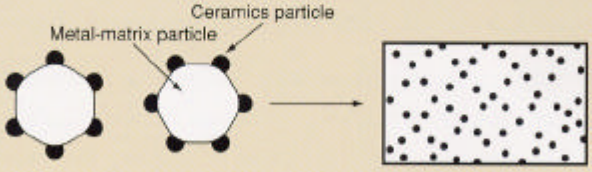
This is a double layered composite particle in which a layer of zirconia superfines and a layer of copper superfines are fused in two steps onto the surface of the stainless (SUS316L) spherical particles.



These are a polyphase composite particles in which a mixture of stainless flake particles and zirconia superfines are fused onto the surface of stainless spherical particles.
The Mechano Fusion System offers a broader array of potential for both various other particle combinations and morphological designs.
(Typical applications: high-temperature, high-strength materials)

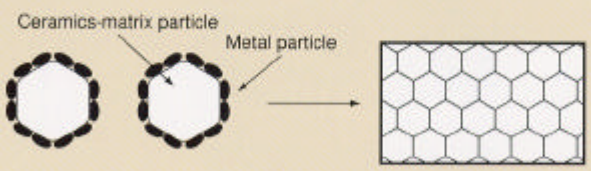
(1—5) Control of the covering fraction of the particle-to-particle fusion and that of the structure of a formed product

(a) Preparation of composite materials in which particles of another type are dispersed
(Ex. Ceramic particles fused on metal matrix particles)



Fusing ceramic particles at various spots on the metal matrix particles, followed by pressing and sintering, produces a composite material in which the microscopic ceramic particles are dispersed in the matrix.

(b) Production of network structure composite material
(Ex. Metal particles fused onto ceramics-matrix particles)

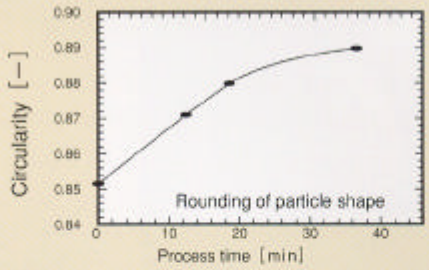


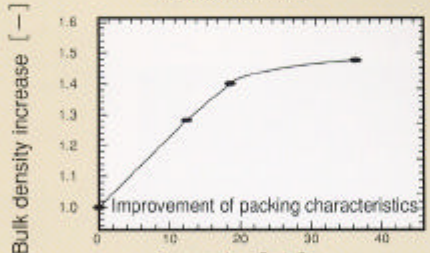
Composite particles in which superfines cover the entire surface of the ceramics/metal-matrix particles can be employed to produce electrically conductive ceramics base materials and electrically insulative metal base materials.

2. Particle shape control
(2—1) Sphericalization (cell material)

Before Mechano Fusion

After Mechano Fusion



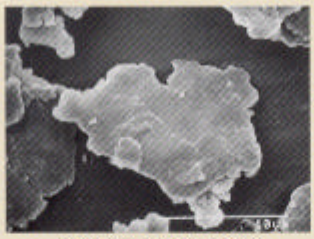


(in the case of AMS-60F)

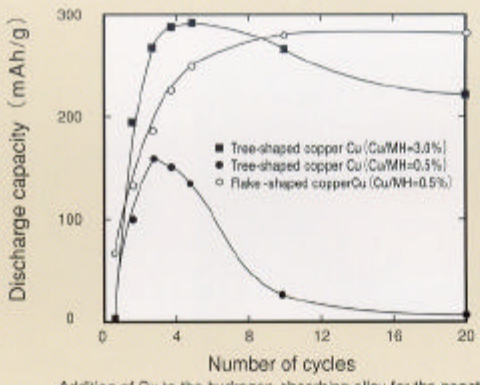
The Mechano fusion technique generally serves to make particles more spherical in shape, and is employed to improve particle fluidity and packing density, as well as to control particle electrification.

(2—2) Flattening[※3] (cell material)


Before Mechano Fusion


After Mechano Fusion

Flattening of copper particles

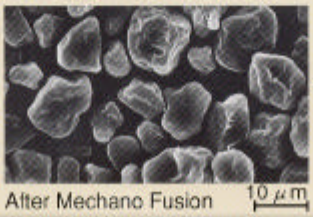


Addition of Cu to the hydrogen-absorbing alloy for the negative electrode of a nickel-hydrogen battery and its impact on particle forms

The proper setting of Mechano Fusion process conditions can permit the flattening of the metal particles being processed. Flat particles prove to be significantly effective in the enhancement of product quality when applied as electric cell materials, special paint for electronic parts and various types of fillers.

(2—3) Sphericalization performed simultaneously with particle fusion (toner)


Before Mechano Fusion 10 μm


After Mechano Fusion 10 μm

It is possible to prepare toner products that excel in fluidity and possess adequate electrification properties by forming the angular toner particles into spherical shapes while fusing the static charge controlling and fluidity improving agents.

3. Mechanical powder fusion
(3—1) Hue comparison

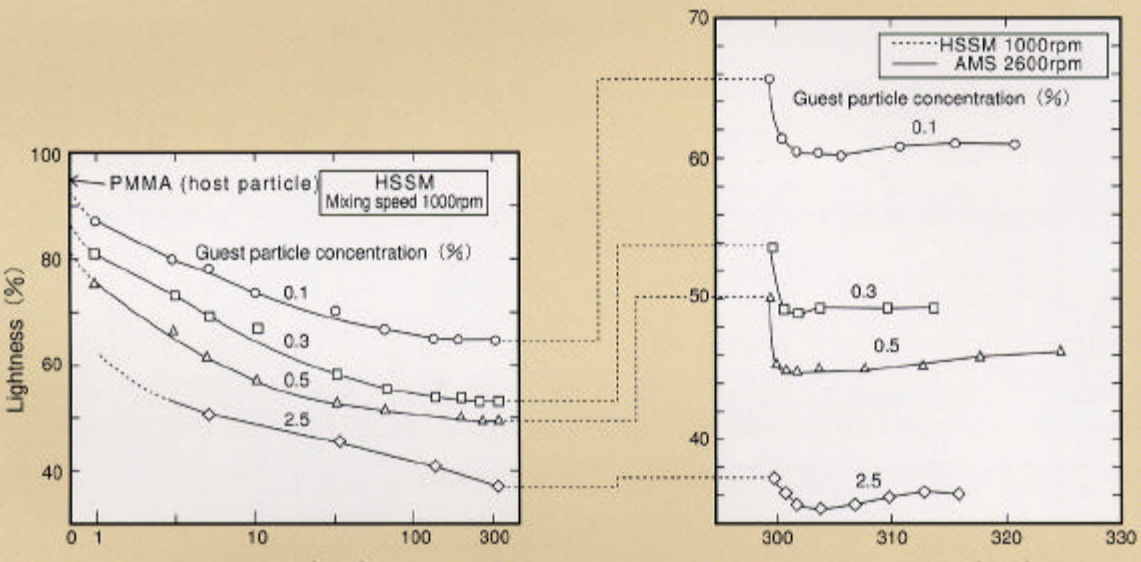
A blend of yellow iron oxide and blue dye (5wt.%)

The product processed by a conventional high-speed mixer

The product processed by a Mechano Fusion process

The Mechano Fusion process generates strong compression and shear forces that disperse particle aggregates finely and blend the dispersed particles precisely. At the same time, this methodology can achieve the mechano-chemical modification of particle properties. Thus, the resultant product assumes different hues from those mixtures produced by a conventional high-speed mixer.

(3—2) Comparison[※4)] in terms of lightness



Process by high-speed mixer (HSSM)

Process by Mechano Fusion System (AMS)
(using a product processed by HSSM 300min.)

Using black magnetite powder (as guest particles) and white PMMA powder (as host particles), an evaluation was carried out as to the mixing effects of a high-speed mixer and a Mechano Fusion System. This test was based on the optical lightness of the test mixture. The mixture produced by the conventional mixer in five hours was processed by the Mechano Fusion System in only a few minutes, which resulted in a substantial decrease of powder lightness. This provides an unmistakable proof that Mechano Fusion is much more effective in finely blending and fusing powder particles.

Reference

※1) P4 — Chen, Z. J., H. Herman and R. Tiwari :
Proceedings of the International Thermal Spray Conference & Exposition, Orlando, Florida, USA, 28 May-5 June 1992, p. 355

※2) P5 — Tanno et al. : J.Soc.Powder Technol. Japan, 30(6),416(1993)

※3) P6 — Yoshinaga et al. : DENKI KAGAKU, 63(9), 847(1995)

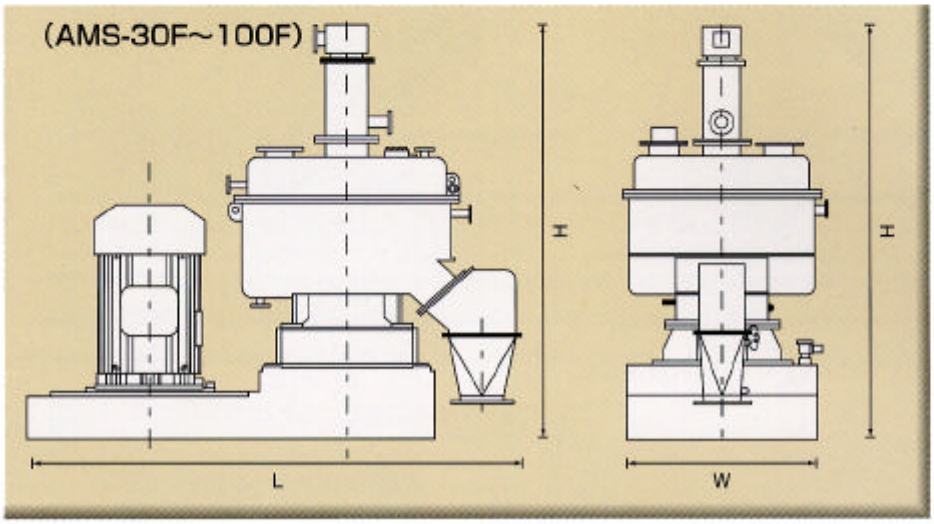
※4) P7 — Alonso, M., M. Satoh and K. Miyanami :
Powder Technology, 59, 45(1989)

Specifications

Model	AMS-LAB (Laboratory type)	AMS-30F	AMS-60F	AMS-100F
Motor (kW)	2.2	Max 30	Max 75	Max 150
Rotor rpm (rpm)	2,650	1,500	1,100	900
Charge (ℓ)	1.2	20	80	200
Total width (mm)	700	600	900	1,300
Total length (mm)	900	1,500	1,900	2,600
Total height (mm)	1,400	1,200	2,300	3,000
Weight (kg)	250	1,000	2,500	5,000

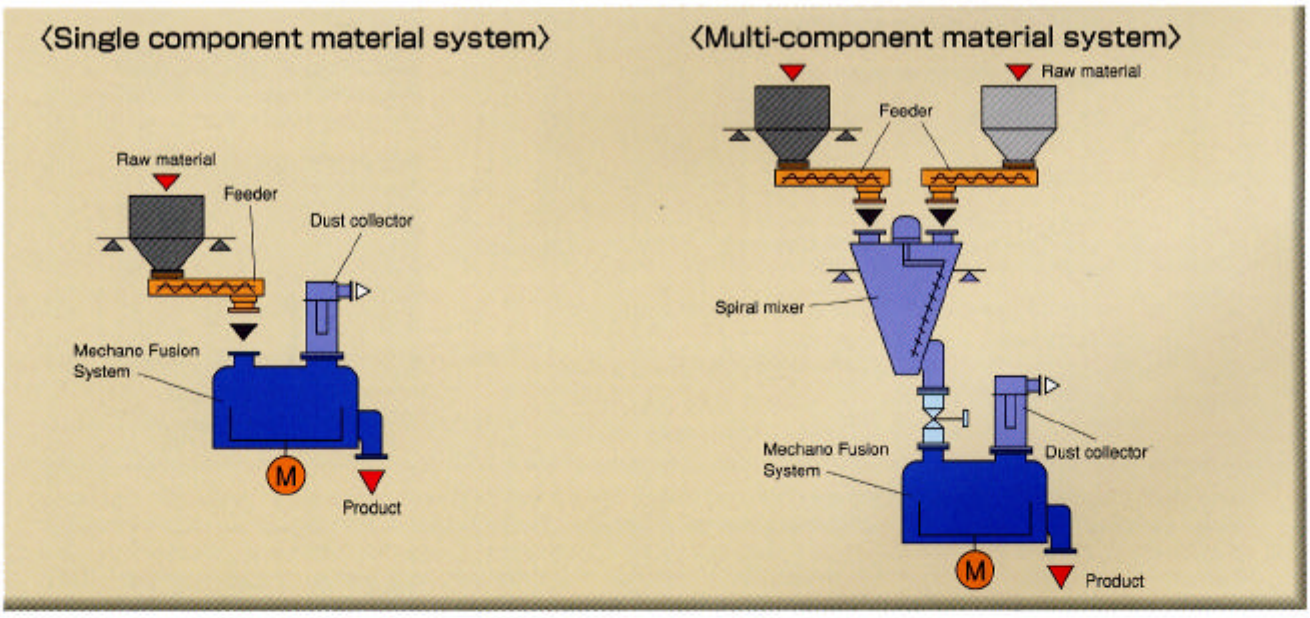
The contents of this specification are subject to change without any prior notice, due to any improvement or enhancement.

Appearance drawing of the body



AMS-LAB

Typical flow sheets



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