

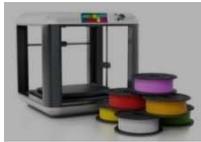


## 3D Ball Mill(3D Reactor) Medium /Small Size

# Proposal of 3D Ball Mill (3D Reactor) that enables highly uniform mixing and milling effect



### ▼ Industries & Issues



Manufacturer of Electric/Metal/ Ceramics /Glass/Chemical

- Aim to improve material quality.  
(High uniform mixing and dispersion without blades is realized utilizing high speed 3D rotation.)
  - Mixture of materials with specific gravity, viscosity difference (metal, ceramics and resin).
  - High uniform mixing of battery material, ceramic material, magnetic material improves product performance.
  - It realizes highly uniform mixing of paste and ink for the electronics.
  - Realize highly uniform mixing and reduce loss during manufacturing process.
- Aims to avoid defects in manufacturing processes due to uneven composition



Paint manufacturer

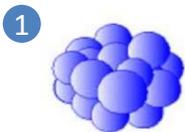
- Aim to improve paint quality to levels far beyond those of competitors
  - High uniform mixing and dispersion of metal(Glass) and organic solvent realized
  - Improve heat resistance/light resistance/water resistance
  - Develop paints not likely to cause color unevenness or blurring
  - Solve larger-sized particle problems and avoid nozzle clogging
  - Improve coloring properties, storage properties, and quick-drying properties



Pharmaceutical manufacturer

- Aim to reduce product disposal costs in manufacturing processes
  - Product disposal costs due to heat generation in manufacturing process
  - Product disposal costs due to uneven mixing in manufacturing process
    - ✓ Fine particles can be delivered into cells with high efficiency. (Improved directing capacity of cell targeting)
    - ✓ Fine particles enable dosage adjustment. (Beneficial for people having comparatively lower swallowing ability like children or the elderly)

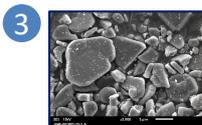
### ▼ Why they cannot solve the issues? & Solutions



1 After 2D motion pulverization, mixture generated fine particles cohere at the bottom.



2 Highly focused impact force causes of thermogenesis.



3 The problem is that particle sizes are not uniform after mixture and pulverization.

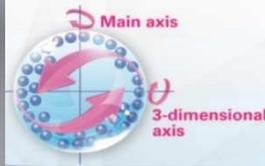
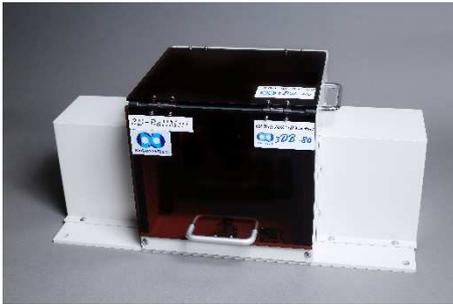


4 Mixing with blades generates shear heat.

■ Solidification, thermogenesis, and non-uniformity in mixture, and unevenness in mixing often occur and affect sales profits.

- 1 **Solidification in high-speed 2D motion dry pulverization, mixture, and dispersion.**
  - **Solution:**  
Achieving no solidification by high-speed 3D motion dry pulverization, mixture, and dispersion. .
- 2 **Thermogenesis problem in high-speed 2D motion pulverization, mixture, and dispersion.**
  - **Solution:**  
Utilizing the entire inner area of the container promotes the dispersion of frictional heat and its generation. Effective with organic and inorganic substances.
- 3 **Uneven particle size in high-speed 2D motion pulverization, mixture, and dispersion.**
  - **Solution:**  
High-speed 3D motion is a batch type mixture that makes use of frictional force. Because it always moves around inside the container, there is no time to solidify.
- 4 **Uneven 2D motion mixing (because of only one axis)**
  - **Solution:**  
Without blade. High-speed 3D motion makes it possible to use entire inner area of container efficiently. Low thermogenesis and uniform mixing can be achieved.

**Small Size 3D Ball Mill (3D Reactor) 3D-80 Batch method [2g(ml)~100g(ml)]**

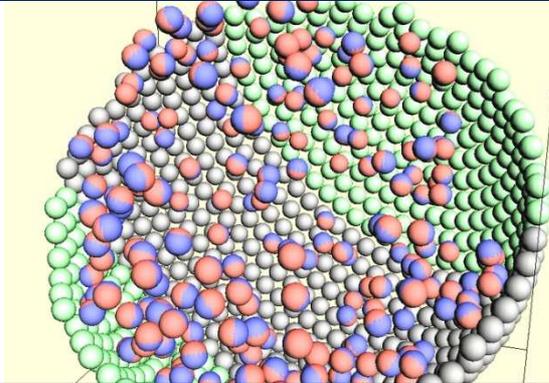


**Characteristics**

- Non criticality by high speed 3D motion
- High uniform mixing and dispersion without blades
- Unused blades are not affected by shear heat
- Reduced heat generation utilizing the entire container
- Mixing and dispersing without destroying the particle shape making use of frictional force

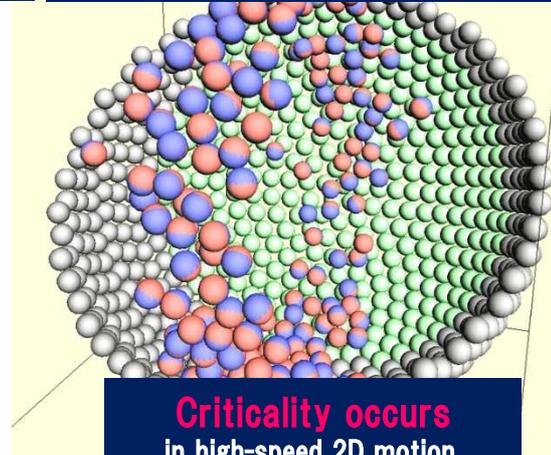
Case: Difference between high-speed 3D rotation and high-speed 2D rotation

**High speed 3D motion (No Critical)**



**Strong friction force rotation** utilizing the whole container. There is **no criticality**.

**High speed 2D motion (Critical)**



**Criticality occurs** in high-speed 2D motion.

- High-speed 3D motion is non-critical. Non-agglomerated and non-solidified particles realized.
- 3D ball mill (3D Reactor) can mix substances of different specific gravities and viscosities uniformly without using blades.

**Experimental results:**

- Implementation of high-speed 3D motion that enabled a new type of pulverization, mixing, and dispersion which was considered to be impossible thus far.

**1 Sesame pulverization experiment**



**2D motion:**

- Pulverization failure with pasted form due to pulverization thermogenesis.



**3D motion:**

- Successful pulverization with little pulverization thermogenesis.

**2 Sesame mixing experiment**



**2D motion:**

- Sesame with low specific gravity moves outwardly
- Salt with high specific gravity moves inwardly.



**3D motion:**

- Uniform mixing of whole content.

**3 Meringue experiment**



**2D motion:**

- Unevenness in mixing.
- Less volume.



**3D motion:**

- No unevenness and uniform mixing.
- Having higher volume as a whole.

▼ Product

Dimension:	Width 585 mm × Depth 310 mm × Height 310 mm((The door opens 460 mm )
Weight:	27 kg
Main axis (vertical) rotational speed:	0–600 rpm
3D axis (horizontal) rotational speed:	0–600 rpm
Actual 3D frame rotational speed	0–1,200 rpm
Power	AC 100 V or 220 V(120 W DC brushless motor 2 units)
Maximum electricity consumption	240 W
Container	Zirconia, alumina, etc.
80 mm sphere container (Maximum processing capacity: approx. 100 mℓ or 100 g)	Metal (S45C, stainless steel, chrome steel, tungsten carbide, etc.)
Matching half-sphere container	Other specifications

▼ Media coverage



TV TOKYO  
WBS 2010.1



J-GoodTech  
2015.2

▼ Customers

- Public administration
  - ✓ The University of Tokyo, Kyoto University, Hokkaido University, Kyushu University, Tohoku University
  - ✓ Advanced Industrial Science and Technology (AIST), National Institute for Materials Science (NIMS), Japan Atomic Energy Agency
- Private sector business (confidentiality, non-disclosure)
  - ✓ Major automaker, major electronics manufacturer, major glass manufacturer, major chemicals manufacturer, major Pharmaceutical manufacturer, major paint manufacturer, many others.

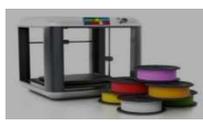
▼ 化学、繊維材料



Conductive pastes



Chemicals,  
fiber materials



3D printer modeling  
materials



Ag nano pastes



Inks, Paints



Metal materials



battery materials



Pharmaceutical  
products



CNT



Cosmetics

The best choice for research institutes, companies, and universities developing new materials using nano-sized and micron-sized fine particles.

▼ Total Cost

**In the first year, approx. 54% total cost reduction has been achieved.**

- In 2D motion, the problem is that fine particles cohere at the bottom during pulverization causing aggregation.  
As a result, restoring efforts are needed after aggregation. (Labor cost of researchers is high.)
- In 3D motion, fine particles continually move inside the container during pulverization. There is no room for aggregation and it does not require any unnecessary processes.

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