

The Basics and Advances of Material Preparation Techniques

Mixing - Pressing - Heating - Coating

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Founder & CEO



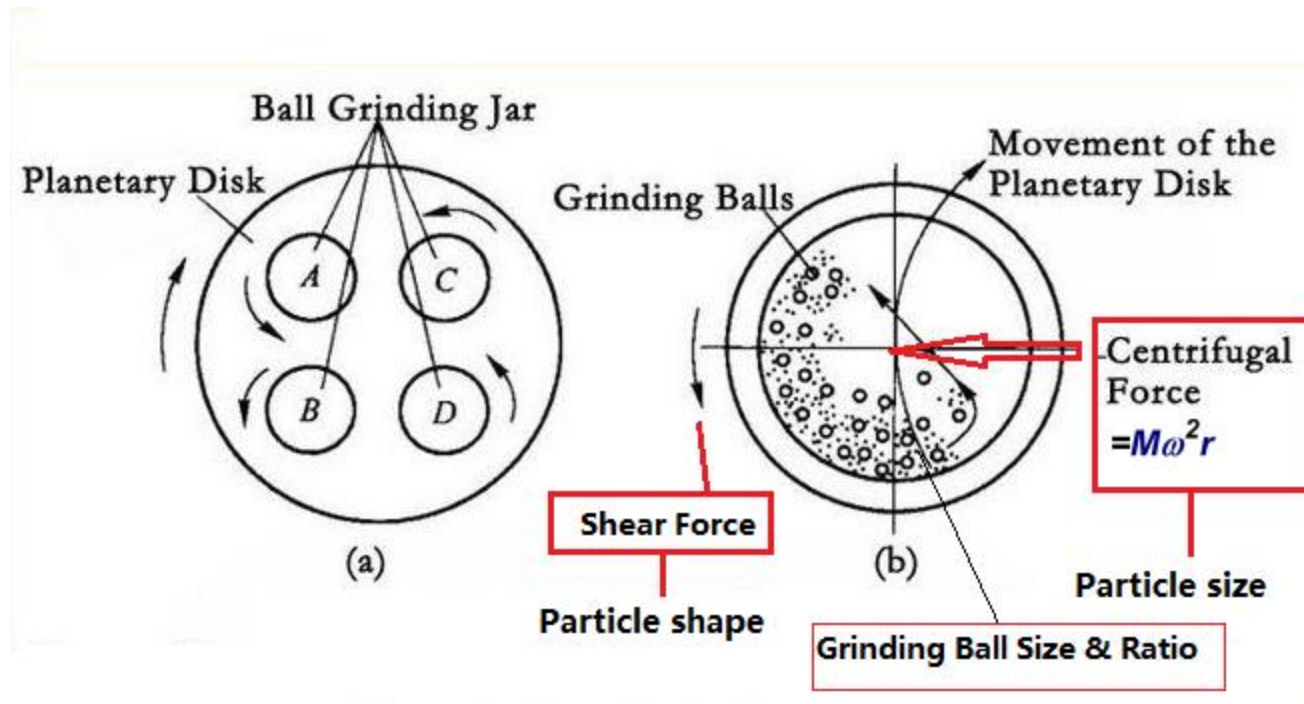
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Planetary Mixing & Milling

- ▶ Basic factors of Ball Milling - Superimposed movement results in **Centrifugal & Shear Force**
- ▶ Selections of grinding ball & jar materials and size - ZrO₂, Al₂O₃, Agate, Nylon
- ▶ 111 Rule for Jar filling - sample : ball charge : free space



Working Principle of Lab Planetary Ball Mill

Advanced Centrifugal Milling & Mixing

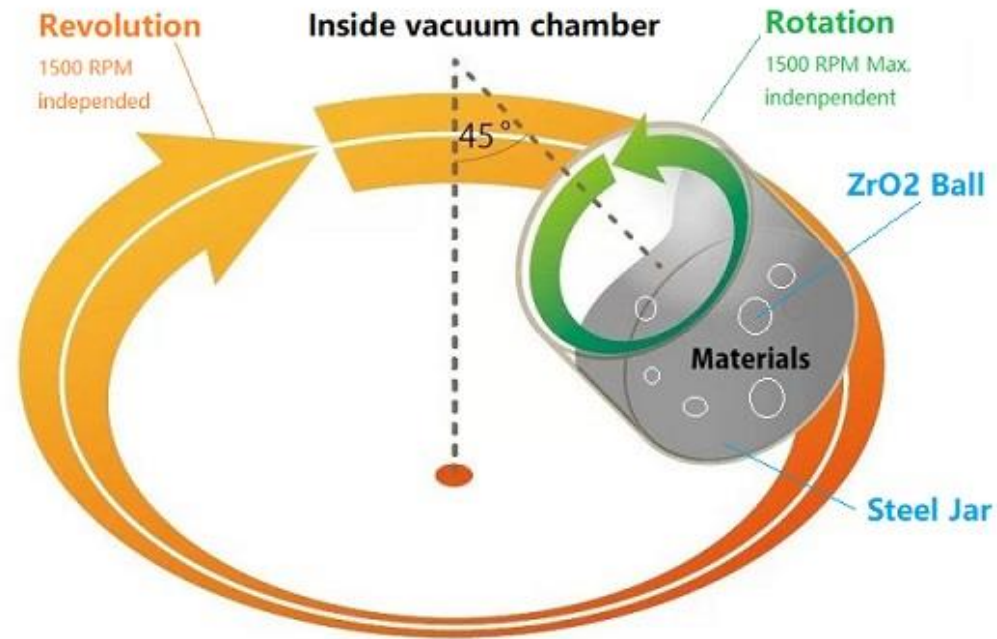
Features:

50 Higher centrifugal Force

Independent control impact & shear force

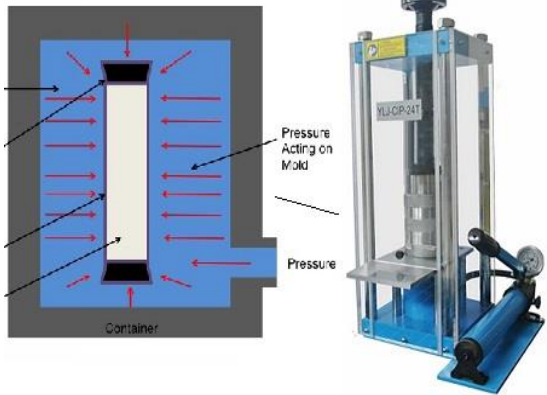
Under vacuum to avoid oxidation

Get << 100 nm particles in several minutes



Sample Pressing

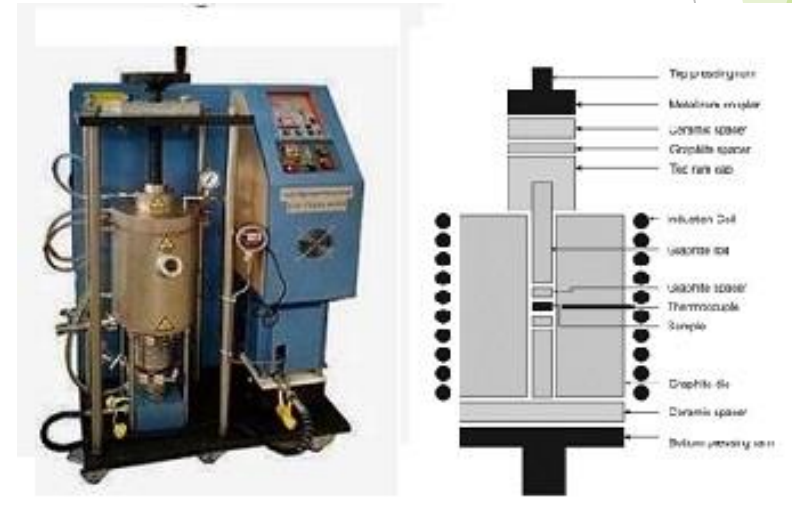
- ▶ Uniaxial pressing at RT: Density < 80%
- ▶ Cold Isostatic Pressing (CIP): Density > 90%
- ▶ Hot Isostatic Pressing (HIP): Density > 95%
- ▶ Vacuum RHP Hot Pressing: Density > 98% (*An alternative low cost option to SPS*)



CIP - 300Mpa



HIP- 1600°C @ 10 Mpa



RHP - 1700oC @ 50Mpa

Heating: Sintering, Melting & Casting

▶ Box / Tube Furnace:

- ▶ 1200 °C, 1500 °C , 1700 °C -- Temp. range determines the cost
- ▶ Heating Zone Const. ≠ Temp. Zone, always check & calibrate by yourself
- ▶ Hybrid Furnace: Tube & box 2 In 1 = save your cost & space

▶ Melting/ Casting: Arc Melting (3000 °C

ng (2000 °C)



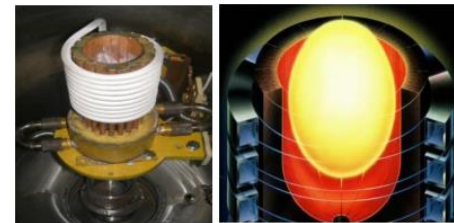
Hybrid Furnace



VIM w/ Sample Feeding & Stir



Arc Melting w/ Cast Mold



Levitation Melting



Top Suction Casting via quartz tube

Rapid Solidification & Quenching

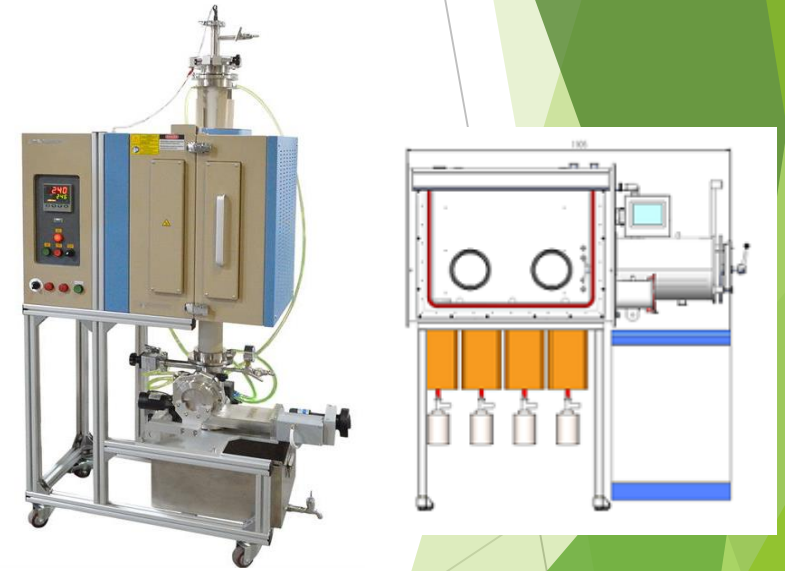
- ▶ Melt-spinning - 10^5 K/s cooling rate to form amorphous foil / flakes for recrystallization
- ▶ Particle casting - 10^3 K/s cooling rate to form 1- 5 mm grains for easy milling
- ▶ Quenching Furnace for studying phase transition - oil/water/gas



Bench-top Melt-Spinner



Induction Melting with
particle casting



High Temp. Furnace with
Quenching Tank

Coating for Thin Film and Powder

► Magnetron Sputtering:

- DC Sputtering for noble metal (conductive material)
- RF sputtering for semiconducting and non-conductive material

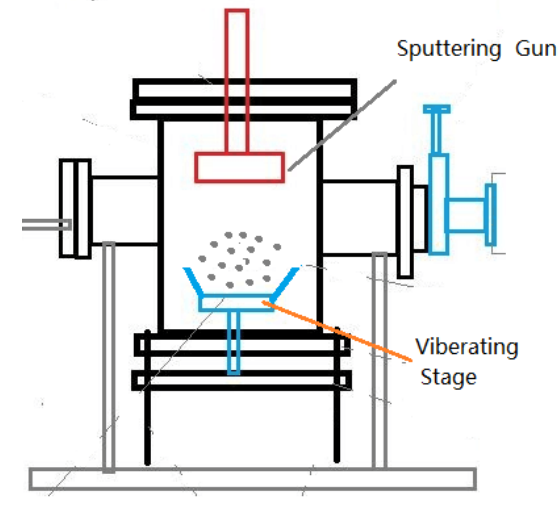
► Coating on Particle Surface: PE- HPCVD, Sputter w/ vibration stage



Dual Source Sputter



Rotary Physical-Chemical



Sputtering for powder

High Throughput Equipment for MGI (Materials Genome Initiative)



Auto Powder Dispenser
(5 Ch. / 64 station)



32 Jar Ball Mill
(Vacuum Jars Available)



16 Die Rotary Press
(1/2"ID Harden Steel Die)



32 Cavities Arc Melting



16 Ch. Furnace w/ Quenching



16 POS Auto-Grinder/Polisher



32 Ch. XRF



32 Ch. Hardness Tester

<http://www.mtixtl.com/high-throughput.aspx>

Summary:

- ❖ Please pay attention: Sample preparation is the essential part of material research. Practice your skills now!
- ❖ MGI approaches the material discovery, development and optimization by dramatically cut down the time and cost.
- ❖ AI material discovery will be highly relied on high-throughput experimental tools and techniques.

Thank you for your support

