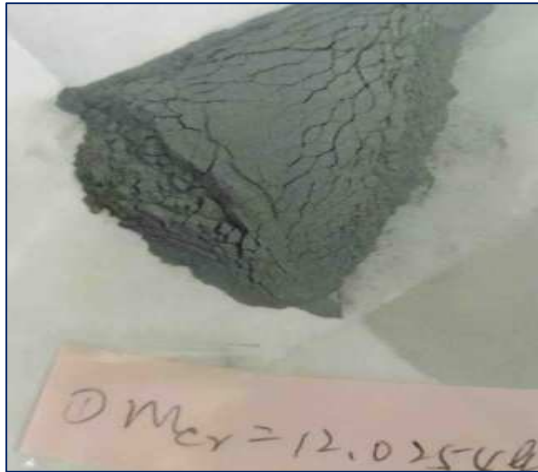


## Mechanical alloying 【Material】



**Chromium Cr**

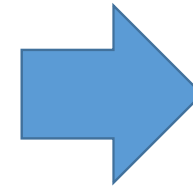
Particle Size 100 $\mu$ m



**Silicon Si**

Lump of 5-20mm  
(Single Crystal)

## Si 【Preprocessing】



**【Preprocessing】**

**We Ground Si in 5mm or Below with the Mortar.**

*We threw Cr, Si into the zirconia pot.*

*We performed an experiment to make CrSi<sub>2</sub> with mechanical along.*

*We performed 120-hour driving examination.*

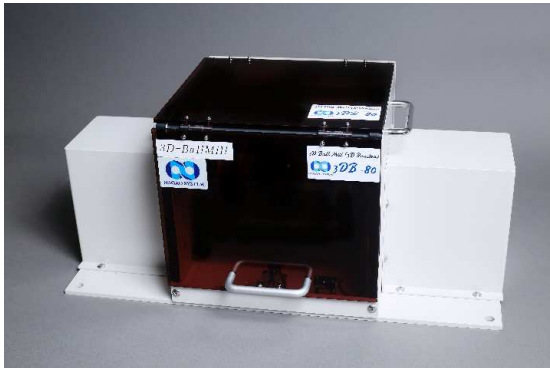
*Material expect as super ultra high temperature materials: CrSi<sub>2</sub>*



**NAGAO SYSTEM**

We used the laboratory wares

**3DB-80**



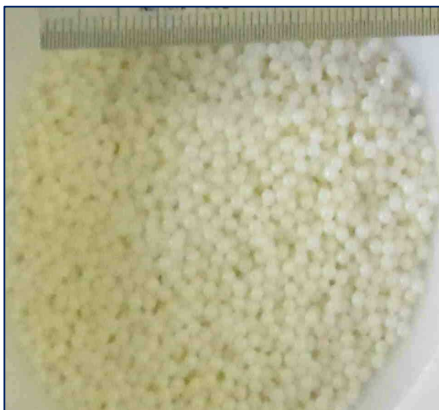
**Glove Box**



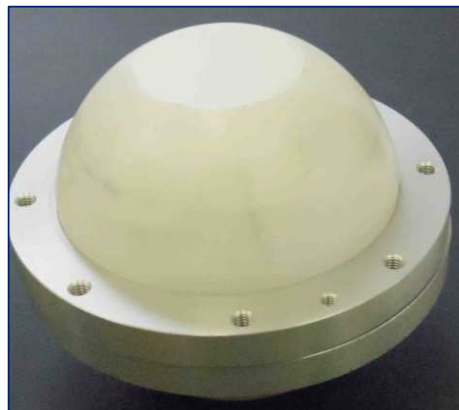
**Experiment [Set]**



**ZrO<sub>2</sub> Ball 2mm**



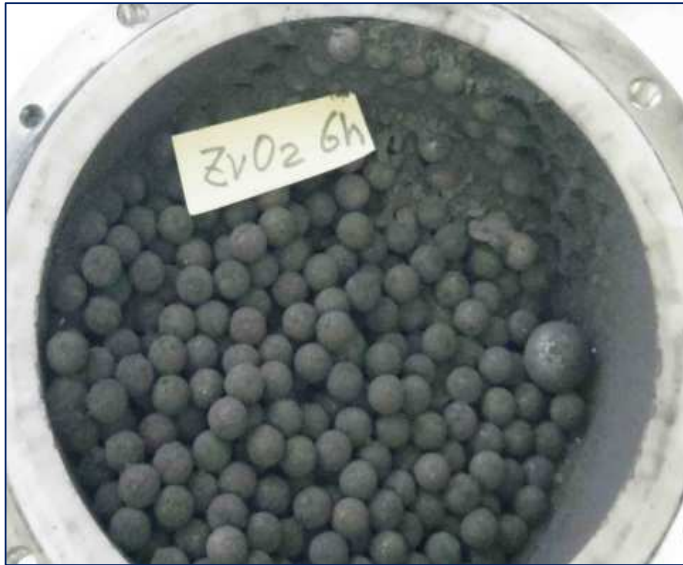
**φ 80mm ZrO<sub>2</sub> Pots**



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm

- To Set Zirconia Pot.
- 3D Ball Mill in a Glove Box.
- Start

## 6 Hour After



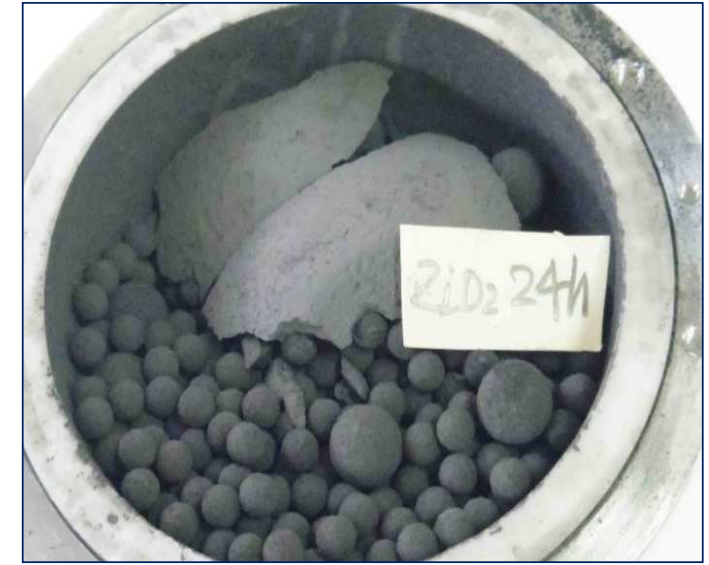
- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.9A**
- Temperature **32°C**  
(Room Temperature 27°C)

## 12 Hour After



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.9A**
- Temperature **38°C**  
(Room Temperature 29°C)

## 24 Hour After



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.9A**
- Temperature **48°C**  
(Room Temperature 30°C)

## 48 Hour After



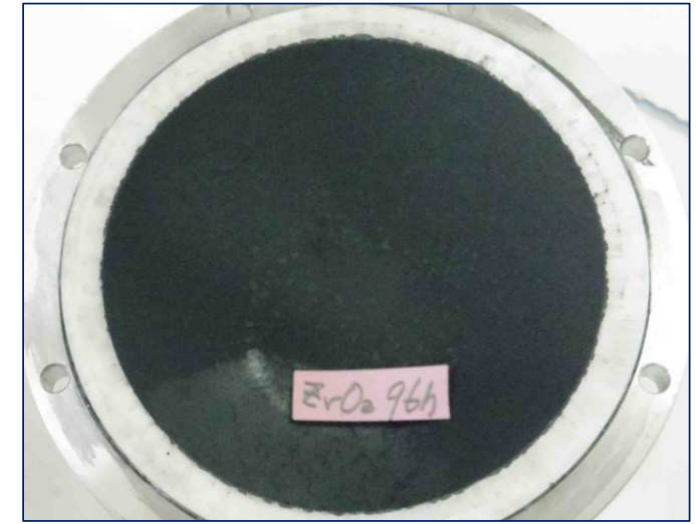
- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.8A**
- Temperature **46°C** (Room Temperature 30°C)

## 72 Hour After



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.8A**
- Temperature **52°C** (Room Temperature 30°C)

## 96 Hour After



- Vertical revolutions : 400rpm
- Horizontal revolutions : 400+400=800rpm
- Total load electric current **0.8A**
- Temperature **54°C** (Room Temperature 30°C)

## 120 Hour After



*Solid bodies of 5cm increased.*  
However, the solids collapse immediately.

- Vertical revolutions : 400rpm
- Horizontal revolutions :  
400+400=800rpm
- Total load electric current **0.8A**
- Temperature **56°C**  
(Room Temperature 30°C)

# Measurement Results of XRD

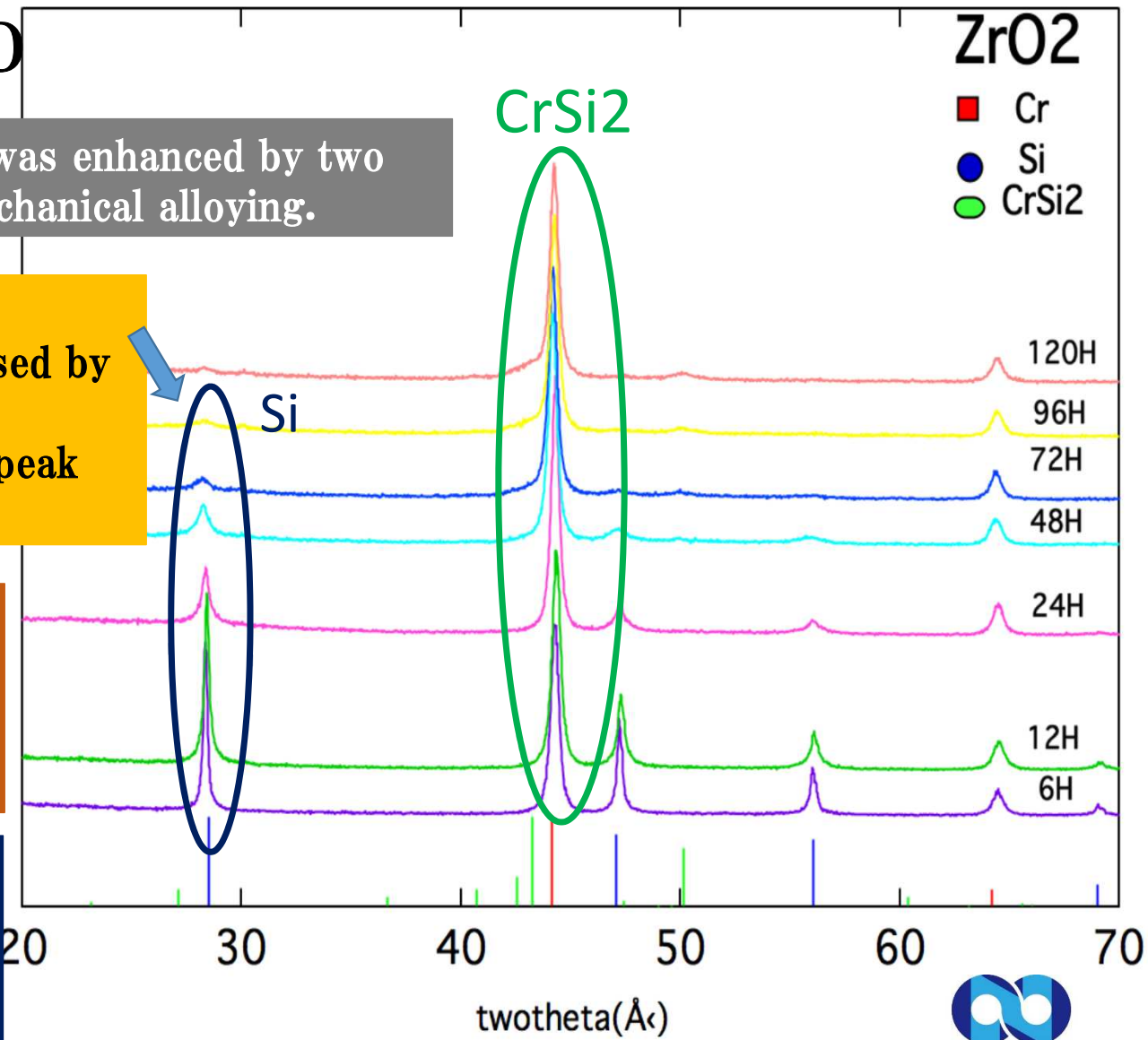
The Cr is very hard. A bigger shock is necessary to make nanoparticles.

CrSi2 was enhanced by two Mechanical alloying.

The high peak gradually decreased by progress at time. There is not the peak 96 hours later

•The planetary ball mill is impossible for the products made in CrSi2 invention.

•The 3D Ball Mill Succeeded to the products made in CrSi2 invention.



## 3D Ball Mill ⇒ Conclusion

- It crush materials less than mm unit to Nano unit from a micrometer.
- It can mix specific gravity, a different material of the viscosity uniformly.
- The dispersion is possible.
- There is no aggregation.
- The inorganic matter and organic milling and mixture are possible.
- It is motion of whole container side. Frictional heat disperses in the whole. There are few temperature rises.

