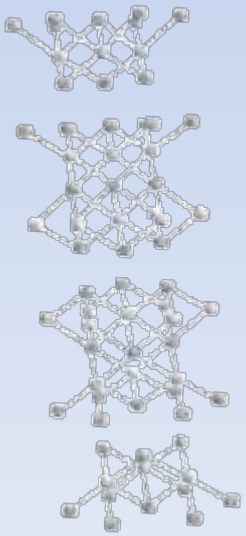
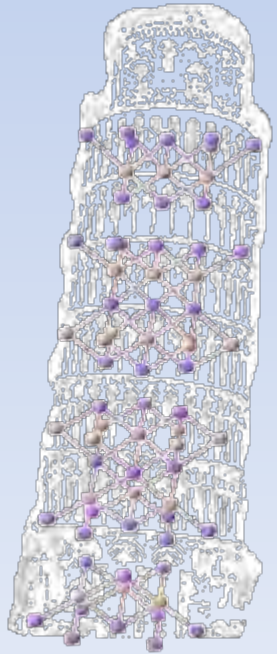
Cold-Press & Electrical stressing



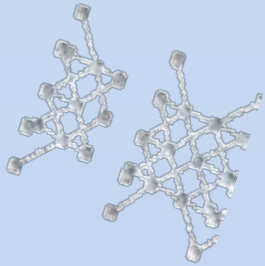


Advisor: Prof. Chien-Neng Liao

Student: Hung-Hsien Huang

Date:2010/08/04

ZT Improvement

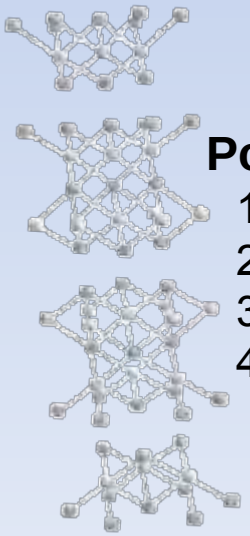


Main directions

1. Decrease grain size → reduce thermal conductivity
2. To change density of state by doping

Fabrication process

1. Single crystalline
2. Powder metallurgy → SPS process
3. Chemical reaction



Powder metallurgy

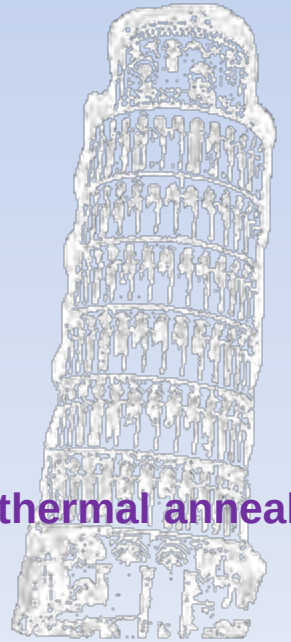
1. Ball milling
2. Mechanical alloy
3. Melt spinning
4. Hydrothermal method

SPS process

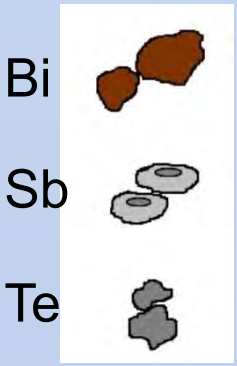
1. 300°C up
2. 50~100 MPa
3. 500~750A

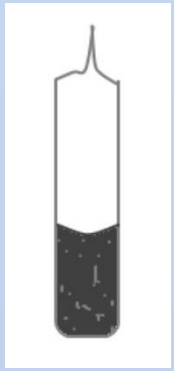
Other treatments

1. **Cold press + current sinter/thermal anneal**
2. **Hot press + current sinter**



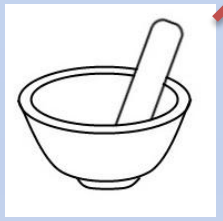
Procedure

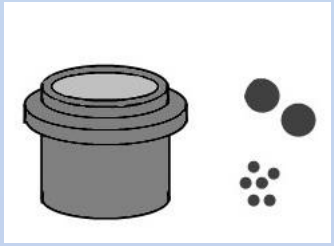




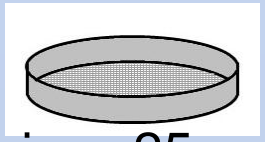
P-type bulk

grind

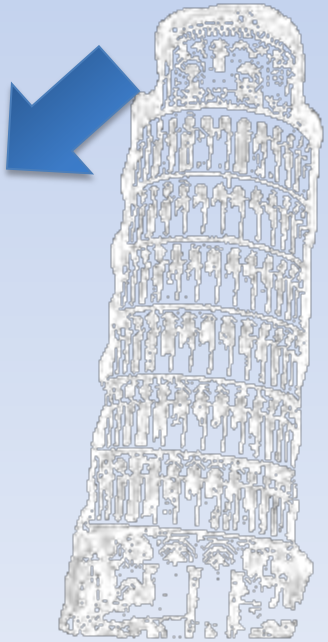


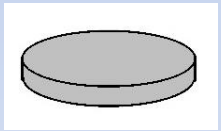


ball milling



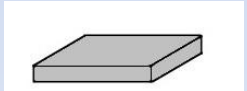
sieve 25μm





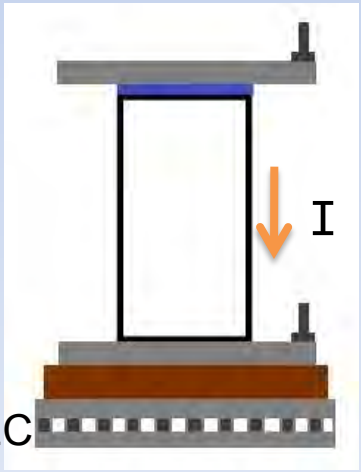
600MPa
3min

cold press

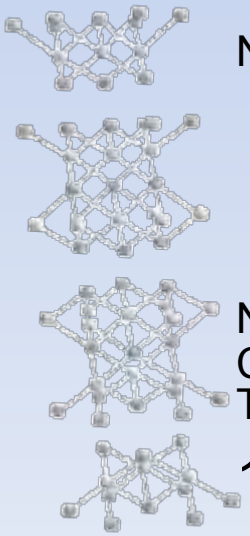


8x10x1 mm^3

Electrical stressing



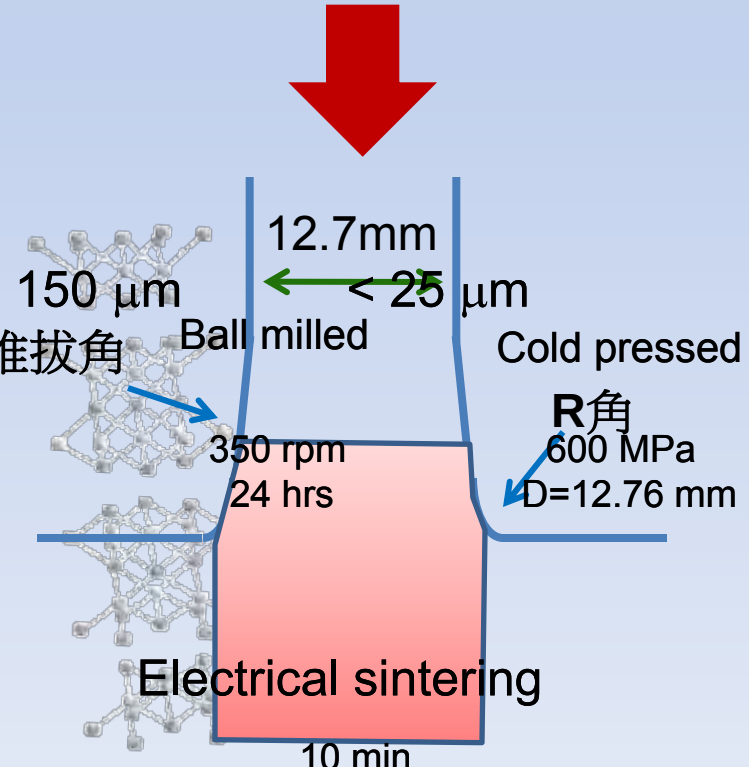
100 A/cm^2, 10min

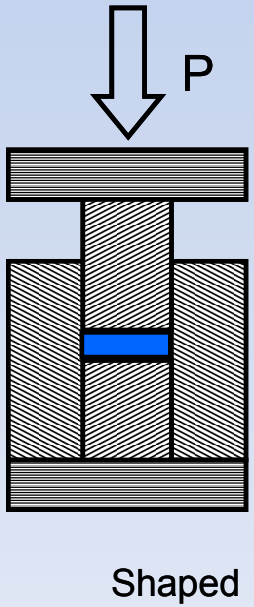


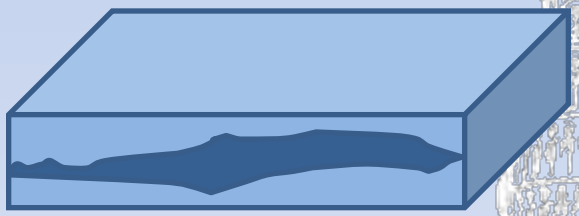
Formability discussion

- delamination [魚鱗紋]
  - Length / Diameter ratio of sample
  - Mold surface roughly
  - Spring back

- Solution
  - Add binder
  - Faster exit mold speed
  - Lower pressure
  - Improve mold







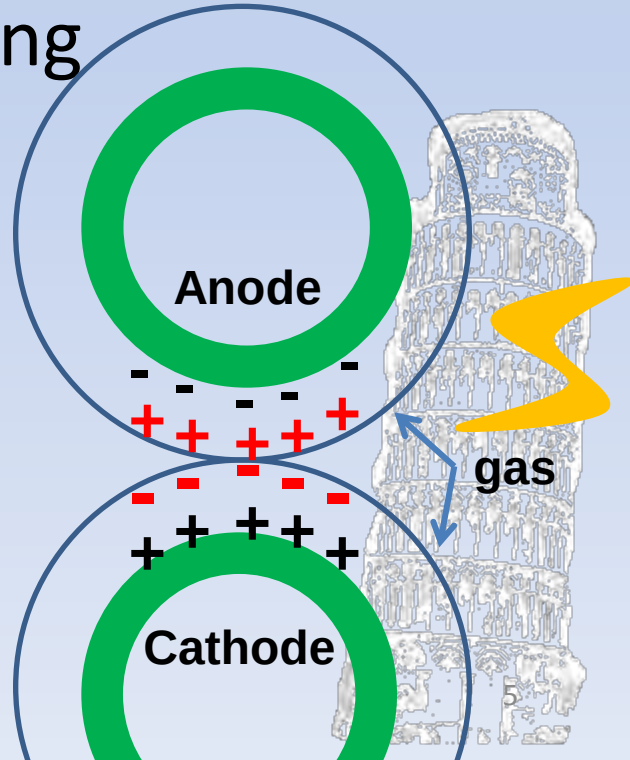
Electrical sintering process

- SPS (spark plasma sintering) process
  (current + pressure)

✓Clean powder surface

✓Enhance the efficiency of sintering

✓Sintering occur on interface

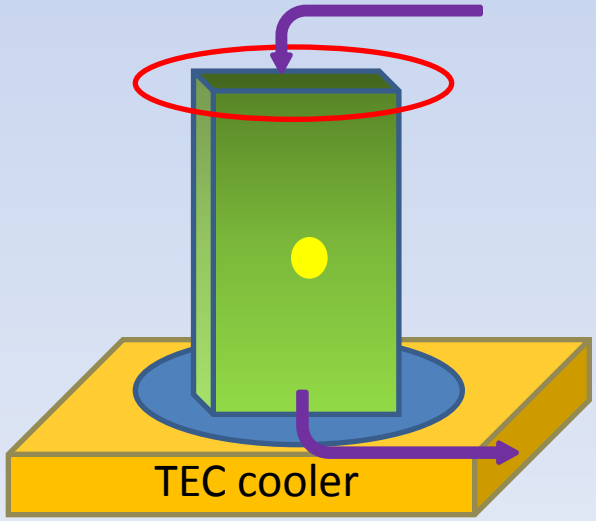


Electrical stressing process

	Carrier conc. (10^{19}/cm^3)	Mobility (cm^2/Vs)	ρ (mΩ·cm)	Seebeck (μV/K)	Power Factor (10^{-4} W/K^{2}m)
As- cold press	3.36	6.7	27.7	210	1.6
Electric sintering	1.30± 0.05	110± 10	4.6± 0.2	320-350	22.26

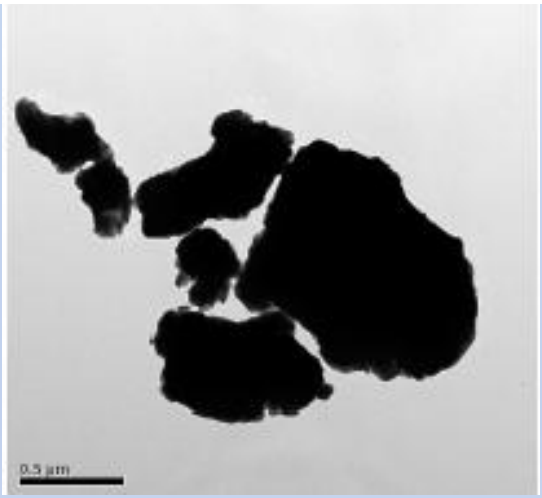
As-pressed → **Electric Sintering**

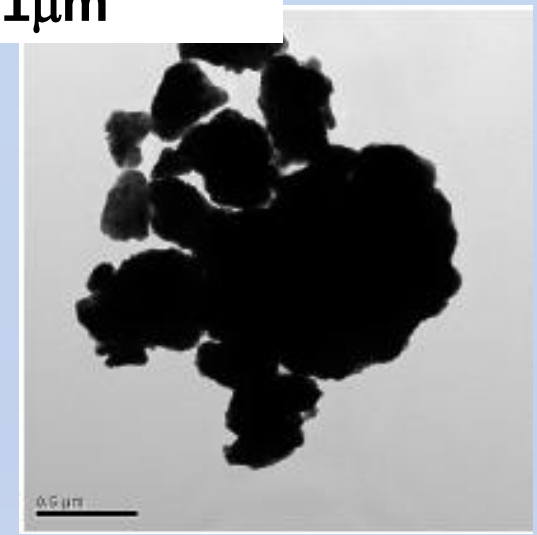
Carrier conc. ↑ Mobility ↓ Carrier conc. ↓ Mobility ↑↑

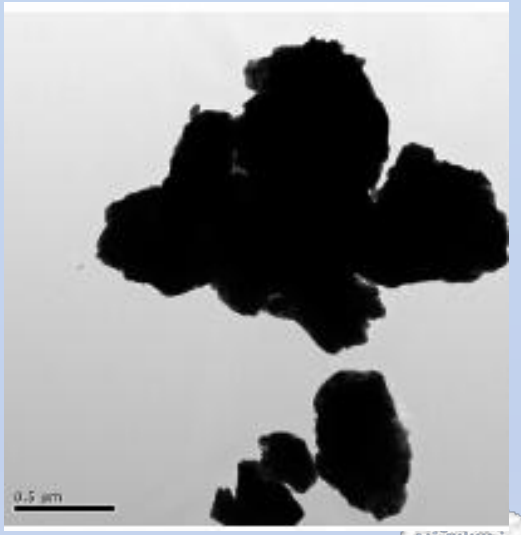


Powder size decrease

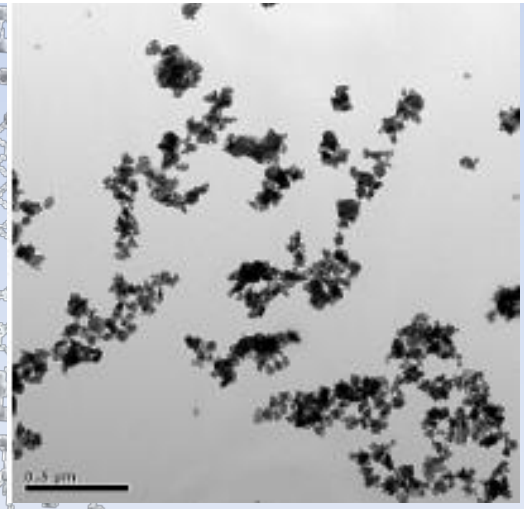
- **Initial powder : 300nm~1μm**

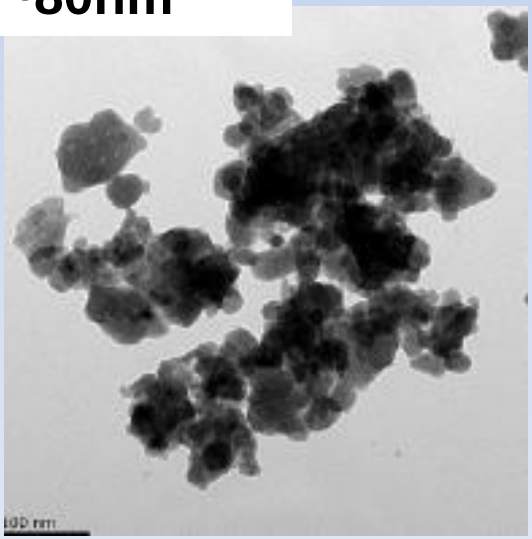


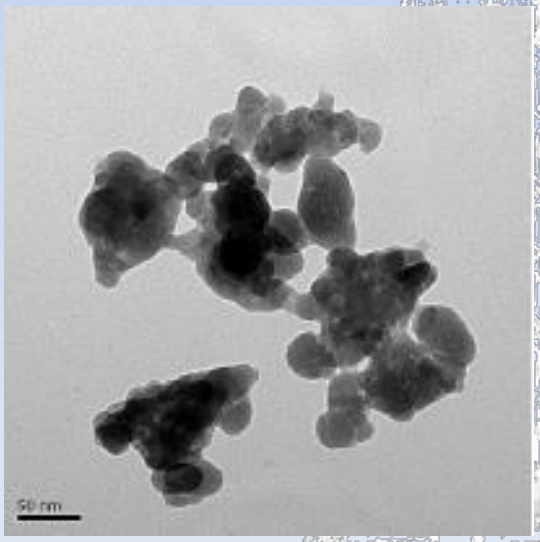


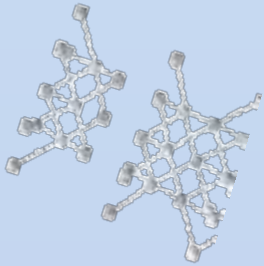


- **After wet milling: 30nm~80nm**









Thank you for your attention!