Technical issues for the future Silicon Wafers

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Why was ϕ400mm studied?

Q2. What have been the SSi main technical success?

Q3. How is the intellectual property rights performance going on?

Q4. What are the key points for sending Technical Information to the Next Wafer Diameter?

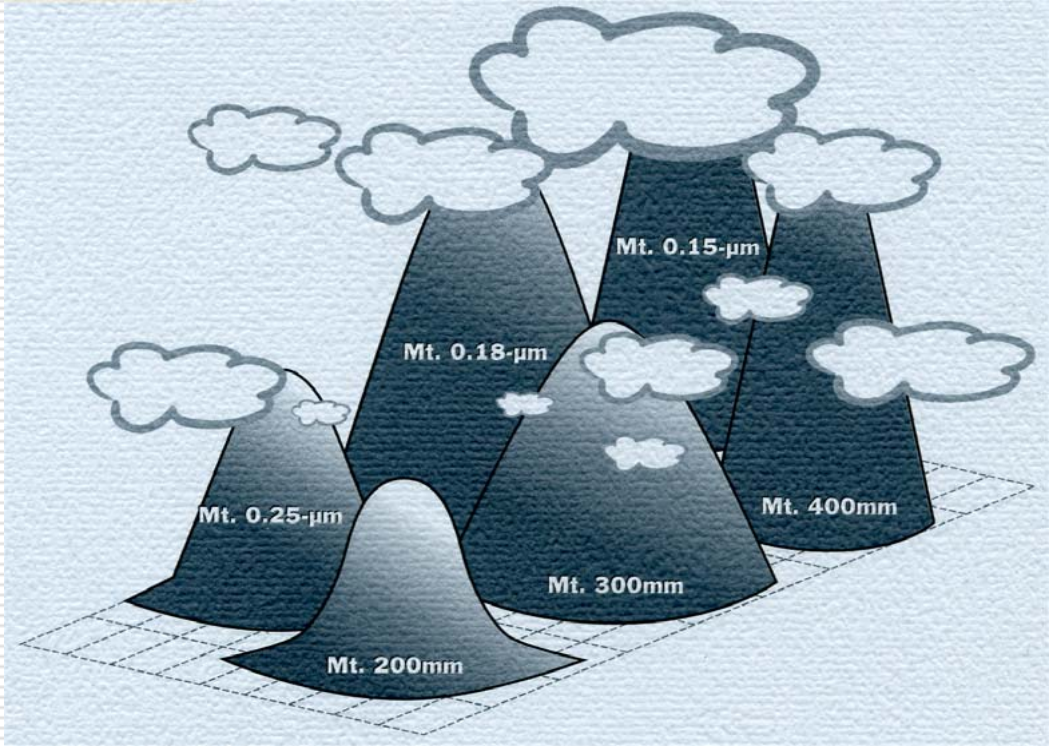
Q1. Why was the SSi consortium formed ?

S = Super = Super Heavy and Large

+

Si = Silicon itself

Q1. Why was ϕ400mm studied?



(Quotation from the regime of SELETE at 1996)

At the SSi establishment, it was a general agreement in the semiconductor industry that the next generation of 300mm was 400mm.

Q2. What have been the SSi main technical success?

A2.

1) Monster CZ crystal pulling furnace by SSi original design.
   (Verification of “Maruyama Patent”, Cusp typed MCZ, etc.)
2) Wafer shaping process by SSi original Grinding Machines.
   (High flatness grinding technology in the lapping-less and etching-less process)
3) Low temperature Epitaxial growth by SSi original design.
   (Highly uniform growth of the super thin layer)

World largest CZ crystal pulling furnace

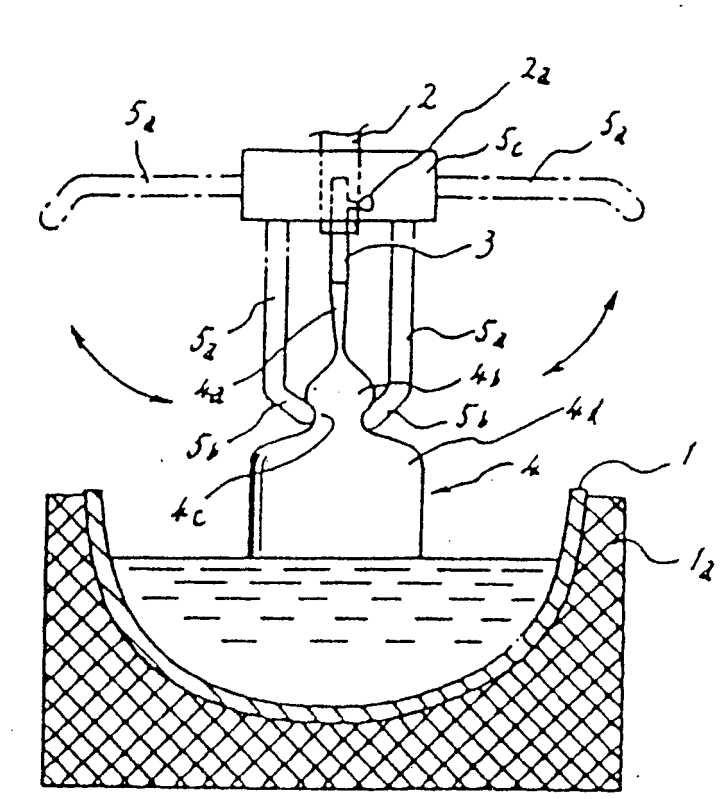
Furnace

- Height: 12 m
- Weight: 36 ton
- Hot zone: 40 inch
- Cusp-type super conductive magnet

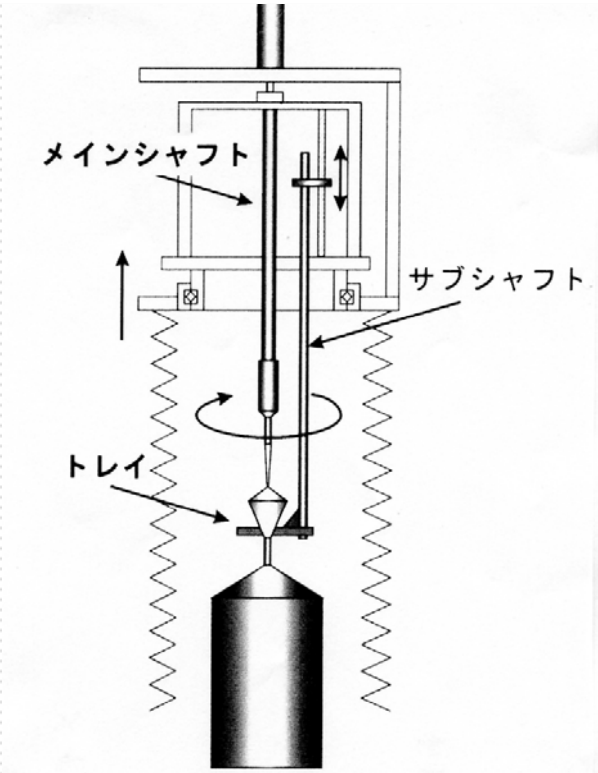
Crystal

- Diameter: 400 mm
- Weight: over 400 kg
- Body length: over 1m

Crystal Supporting System



M. Maruyama: Patent No. 1851653

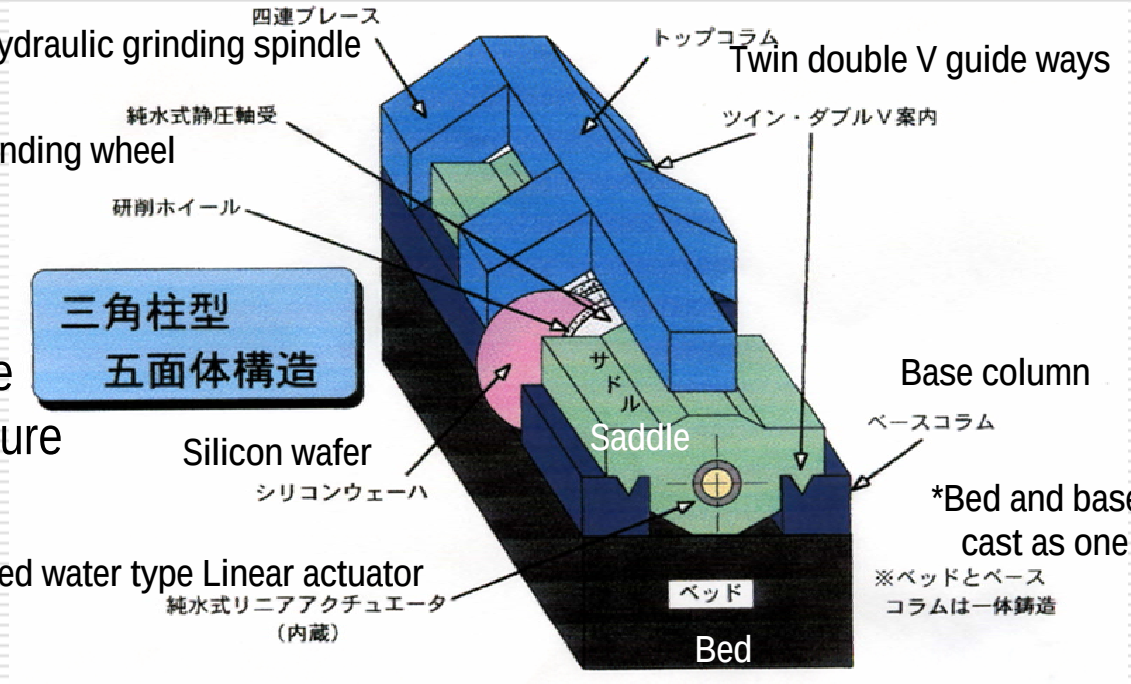


Schematic drawing of built-in system in SSi furnace

The world's first Si single crystal weighing more than 400Kg in a 400mm diameter

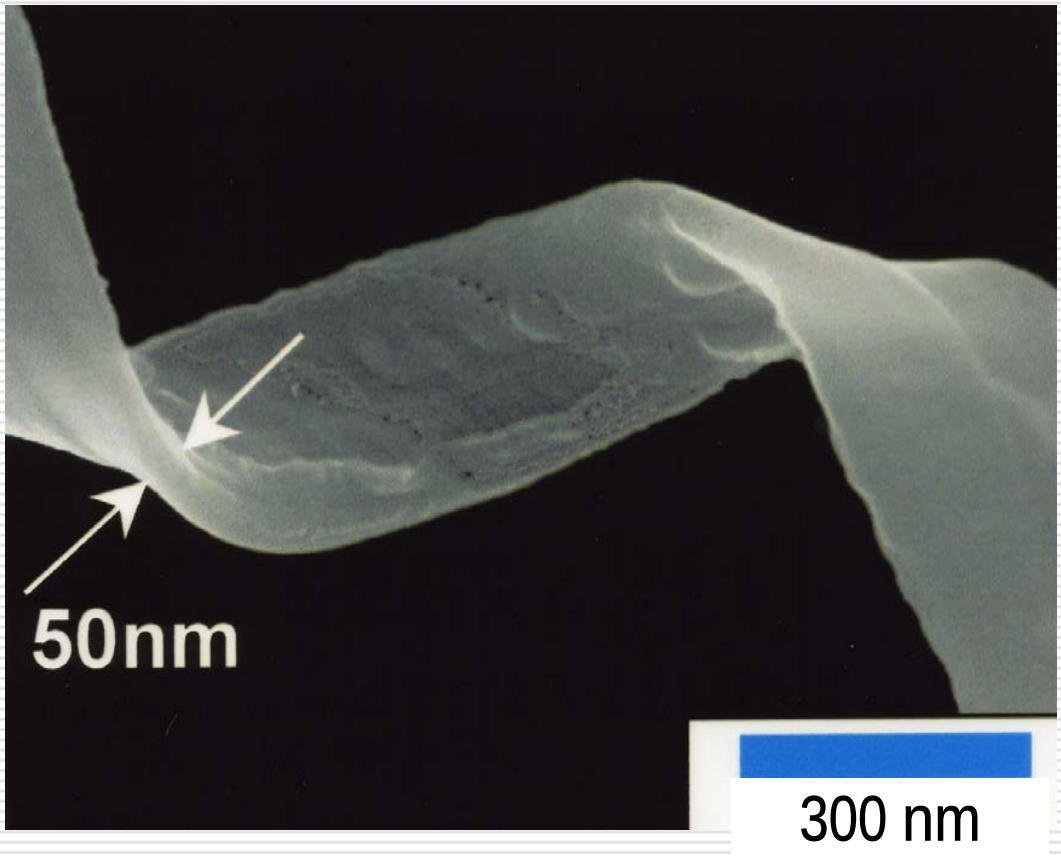
400mm Si single crystal, which has a straight length of 110cm and a total weight of 411kg, is shown in contrast with normal 200mm crystal.

Simplified wafer shaping process by Grinding Technology



Schematic view of Ductile Mode Double Disk Grinding (DDG) Machine for Super-Large and Super-Flat Silicon wafer.

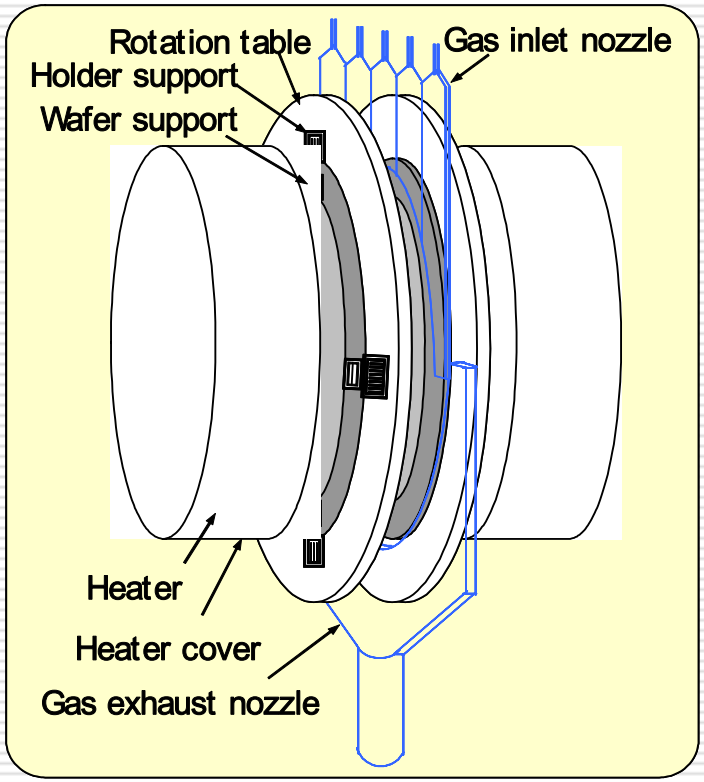
SEM photograph of cutting chip



By the extremely high stiffness , motion accuracy, feeding resolution and fine mesh grinding wheel, a portion of Ductile-mode grinding was searched.

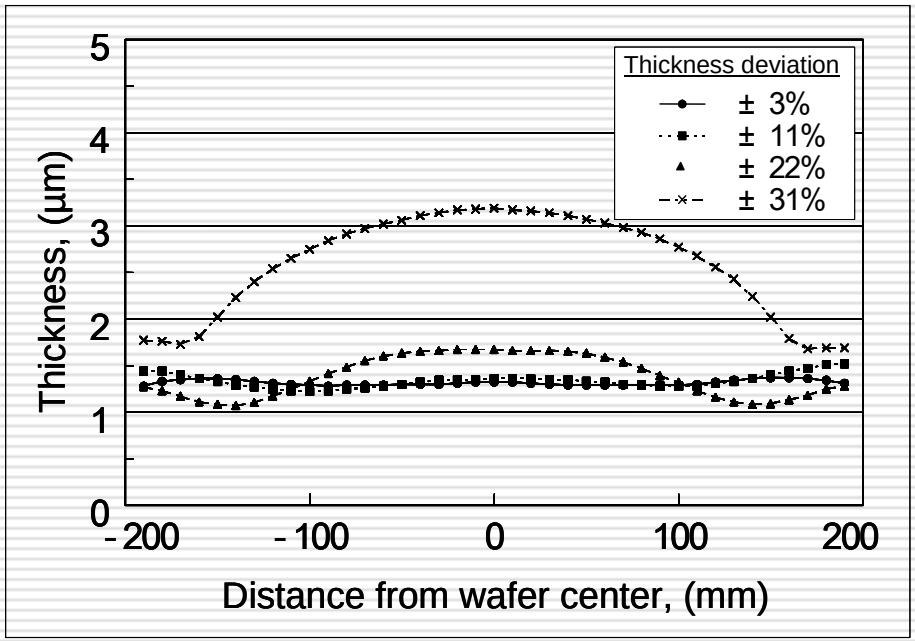
Q3. How is the intellectual property rights performance going on?

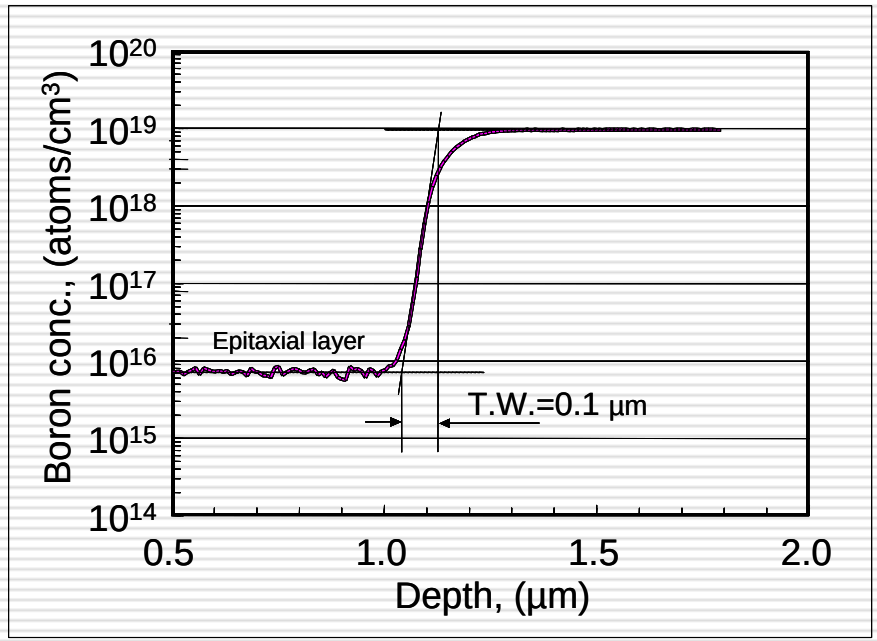
A3.



Among the many patents of SSi, the basic patents of Epi reactor are licensed to Tera Semicon (Korea).

Results of 400mm epitaxial wafers





Note that the thickness distributions change drastically depending on the gas flow rate adjustment of each inlet nozzle. Thickness uniformity commensurate with industrial levels has been achieved. The transition width of 0.1μm is a very steep one compared to that of approximately 0.5μm for wafers grown by conventional $SiHCl_3$ process.

Q4. What are the key points for sending Technical Information to the Next Wafer Diameter ?

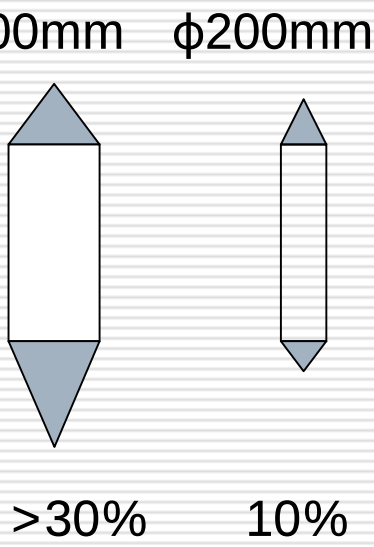
A4.

Field	Technological Issues	Remarks
Crystal Growth	Standardization of Numerical Simulation and Thermal Properties.	Δ ~ X
	Furnace system concept including MCZ, Crystal Suspending system, Larger Quartz Crucible, Safety system, etc.	O
Wafer Shaping	Simplified Wafer Shaping process by Grinding Technologies with Ductile - mode.	O ~ Δ
	High purity cleaning technology.	X
Epitaxial Growth	Low Temperature Epitaxial Growth Technology.	O ~ Δ
	Epitaxial Furnace Design with the intention of Cost reduction.	O
Metrology	Defect & Particle Detection Technology.	X
	Nano-Metrology System measuring the price detection of wafer shape.	O

Remarks:
O SSi information will be much effective.
Δ Some of SSi information will be suggestive.
X New technology should be searched.

Commercial Viability for Next Diameter crystal growth is questionable

1) **Additional technologies such as Monster Puller installation with MCZ, giant Quartz Crucible, Suspending System,Remote Control, etc. will be needed. ⇒Higher cost**
2) **Productivity together with slower growth rate will drastically fall down. ⇒ Higher cost**
3) **Unusable Si materials such as shoulder, tail, residue, etc. will increase. ⇒Higher cost**



Concluding Remarks

1. SSi's activity was a milestone to adapt our concept and/or strategy to the new circumstance.
2. SSi patents and know-how would be promised to improve the 300mm Si production and to the next generation wafer.
3. However, the fulfillment of the next wafer would be questionable without Devices, Equipment, Materials and Wafer each makers' concrete cooperation and appropriate sharing of monster investment in advance.