

in-situ heating TEM observation during crystallization of amorphous Si film

It is important to clarify the structural change during annealing process in semiconductor device manufacturing. Heating behavior of materials can be observed at nm level by *in-situ* heating TEM. Information about structural change with heating can be utilized for process development.

in-situ heating TEM

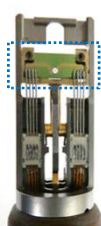
in-situ heating TEM

TEM observation under controlled thermal condition

Temperature control

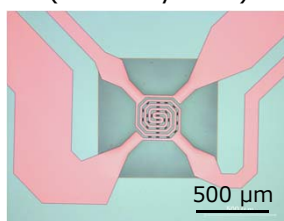
- Temp. range : 23(RT) ~ 1300 °C
- Rapid heating & Excellent stability
- Temp. & Time controlled by program

in-situ TEM specimen holder

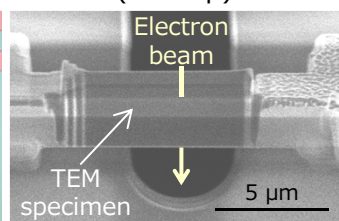


Heating chip

Heating chip (MEMS system)



TEM specimen (on chip)



in-situ heating TEM observation of amorphous Si(a-Si) film

Sample (cross-sectional scheme)

amorphous Si
(100 nm thick)

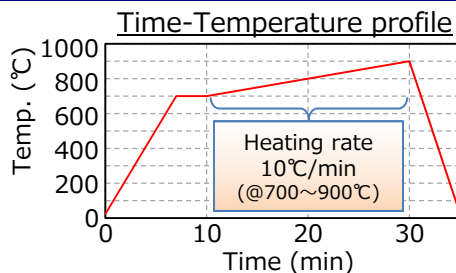
Si sub.

Protective film

a-Si

Si sub.

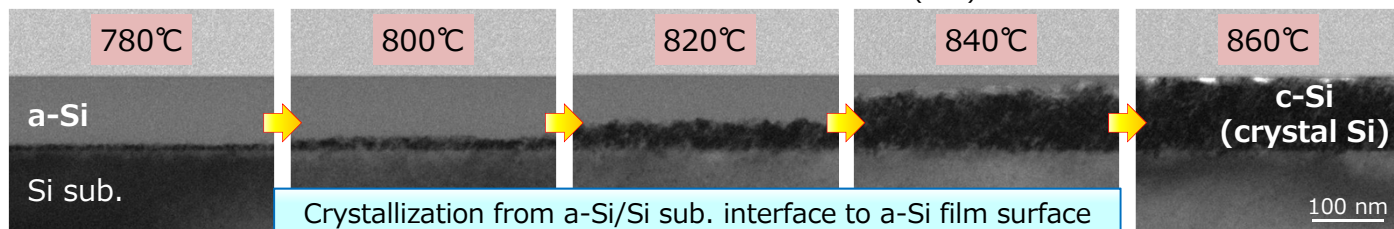
100 nm



Parameter

(Temp., Time)

- Heating rate
- Keeping time etc.



Heating behavior of materials can be observed by *in-situ* TEM.
Cross-section/Plane view TEM, Static/Moving image

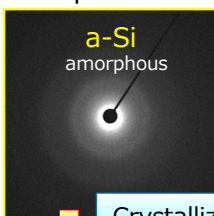
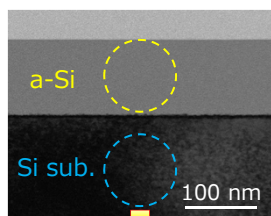
Crystal structure analysis of Si film before and after heating

Cross-sectional TEM

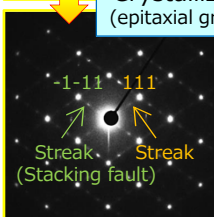
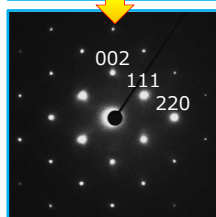
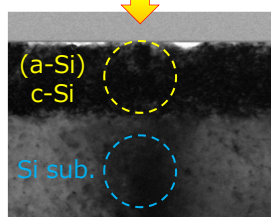
Selected Area ED pattern

Crystal defect evaluation using TEM (after heating)

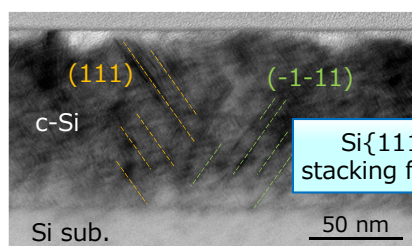
Before



After



Crystallization (epitaxial growth)



Si{111}: stacking faults

Combinations of *in-situ* TEM and other method(SAED,EDX)