

DEVELOPMENT OF EUV PELLICLE WITH SINGLE CRYSTAL SILICON MEMBRANE

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“Development of EUV pellicle with single crystal silicon membrane” Shoji Akiyama, Yoshihiro Kubota
2010 International EUVL Symposium Kobe, Japan



Why Pellicle for EUV Lithography?

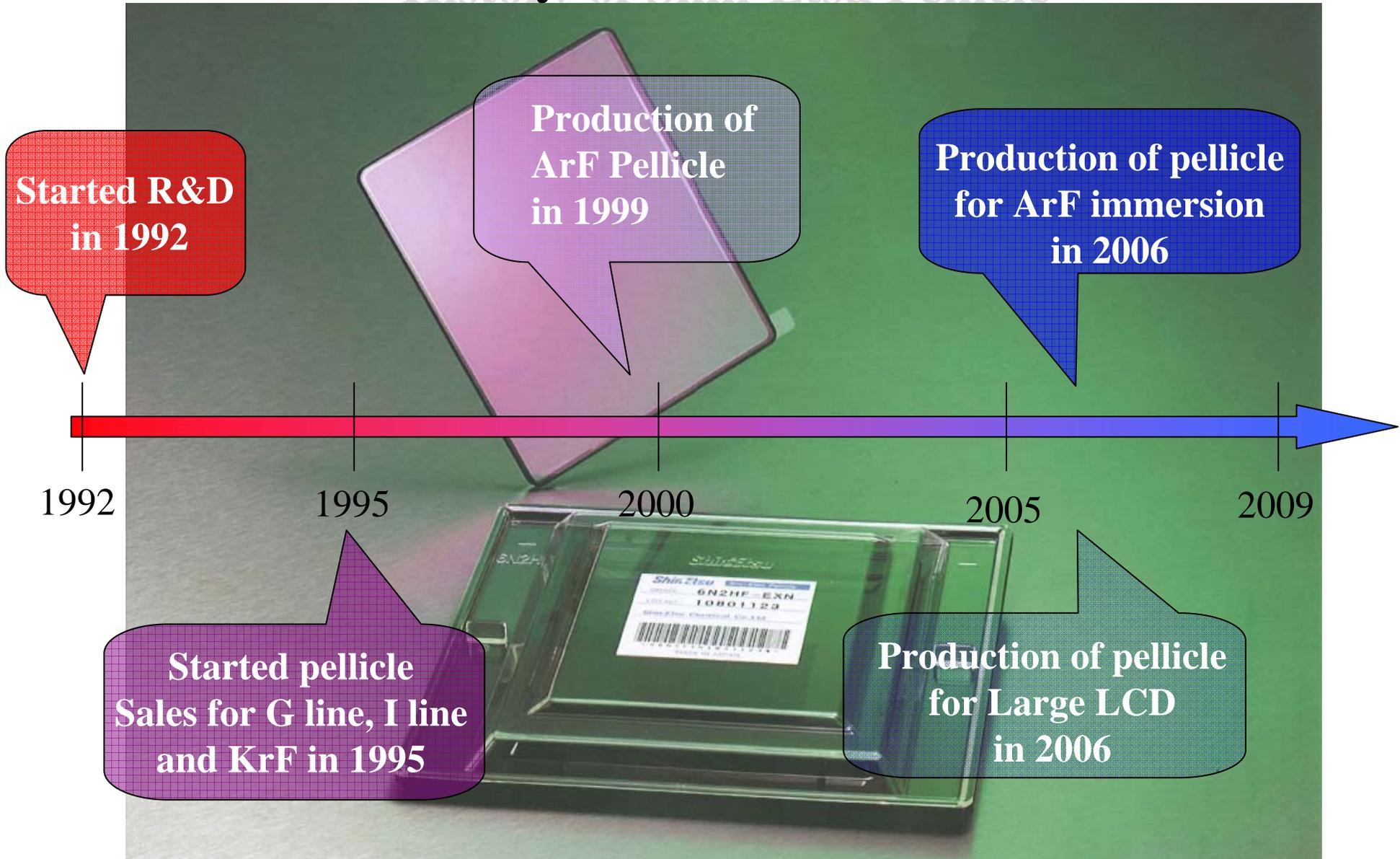
- **Extensive studies on particle addition during “reticle transfer” have been done so far with superior results.**
- **What about particle addition or carbon contamination during “EUV exposure”?**
- **Most EUV programs have been in progress based on the assumption that “there is no particle contamination in EUV chamber”**
- **How can device manufacturers guarantee “Production yield”?**

Without Mask protection, EUV can't be launched, I think.

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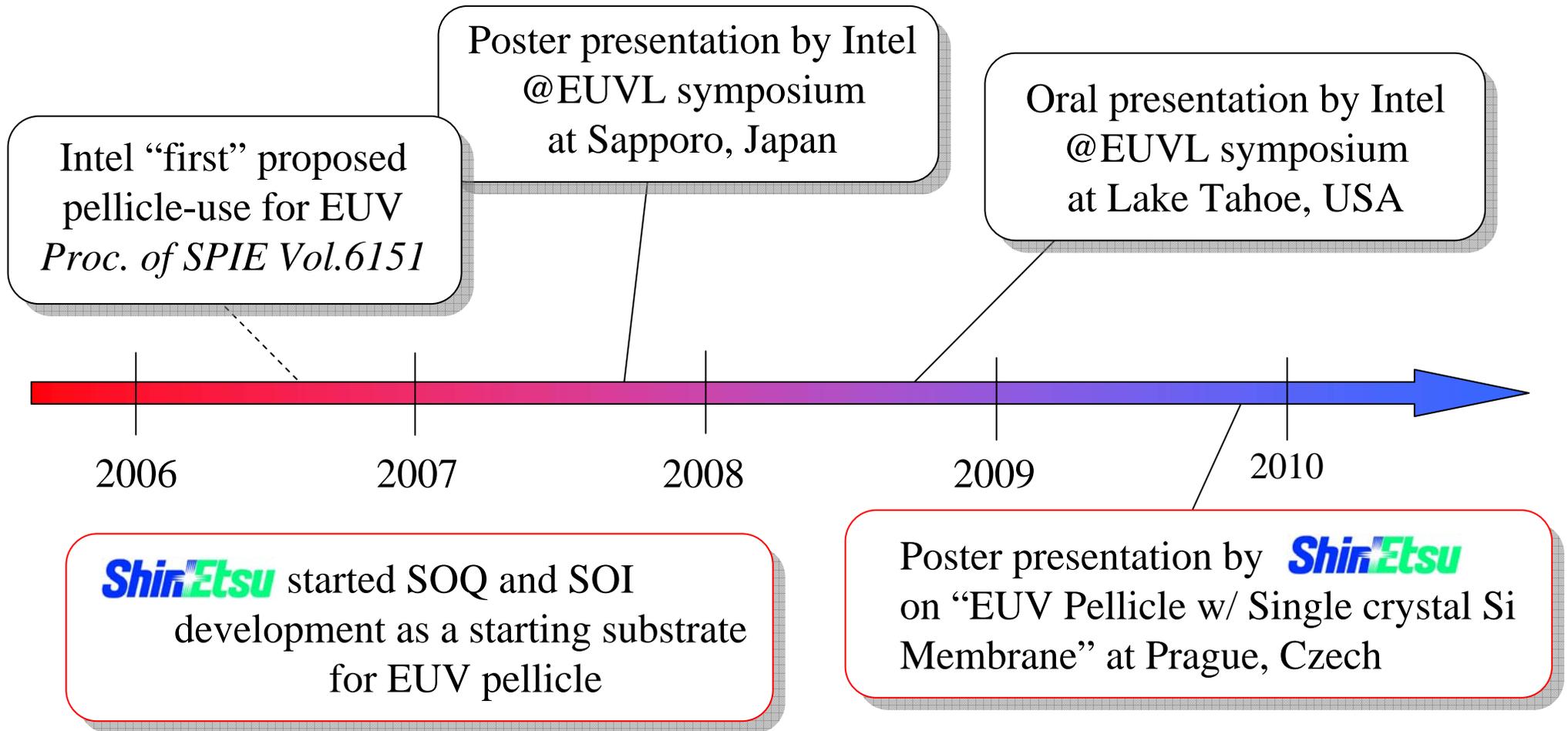
History of Shin-Etsu Pellicle



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Brief History of EUV Pellicle



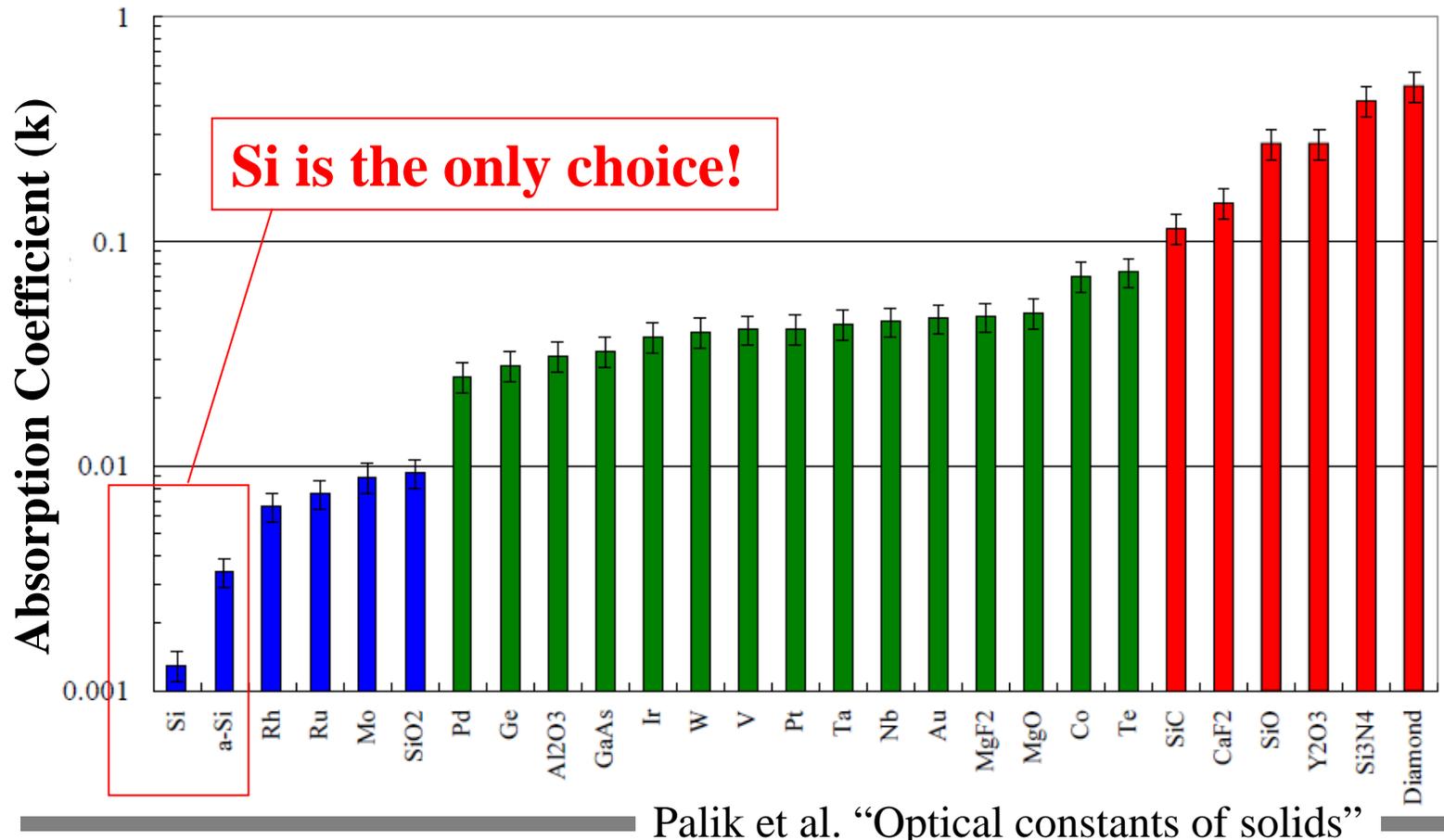
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Basic requirements for EUV Pellicle

- **No organic component included**
- **High transmissive film for EUV domain**
⇒ **single Si crystal is one of the choices**
- **No wrinkle on pellicle film for easier inspection**
⇒ **Slight tension in pellicle film needed=Precise stress control necessary**
- **Mature CMOS technology utilized**

Absorption of Inorganic materials @EUV(13.5nm)

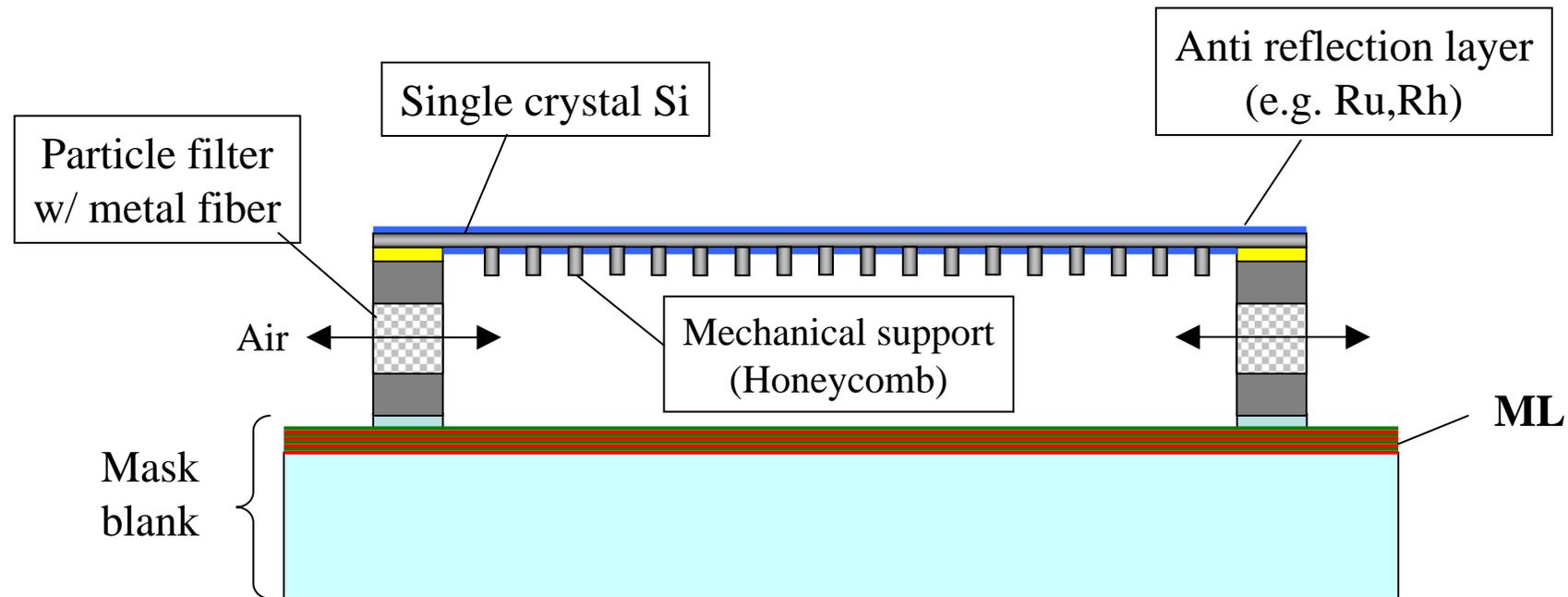


Single crystal Silicon is chosen as EUV pellicle membrane

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Proposed structure of Shin-Etsu EUV pellicle

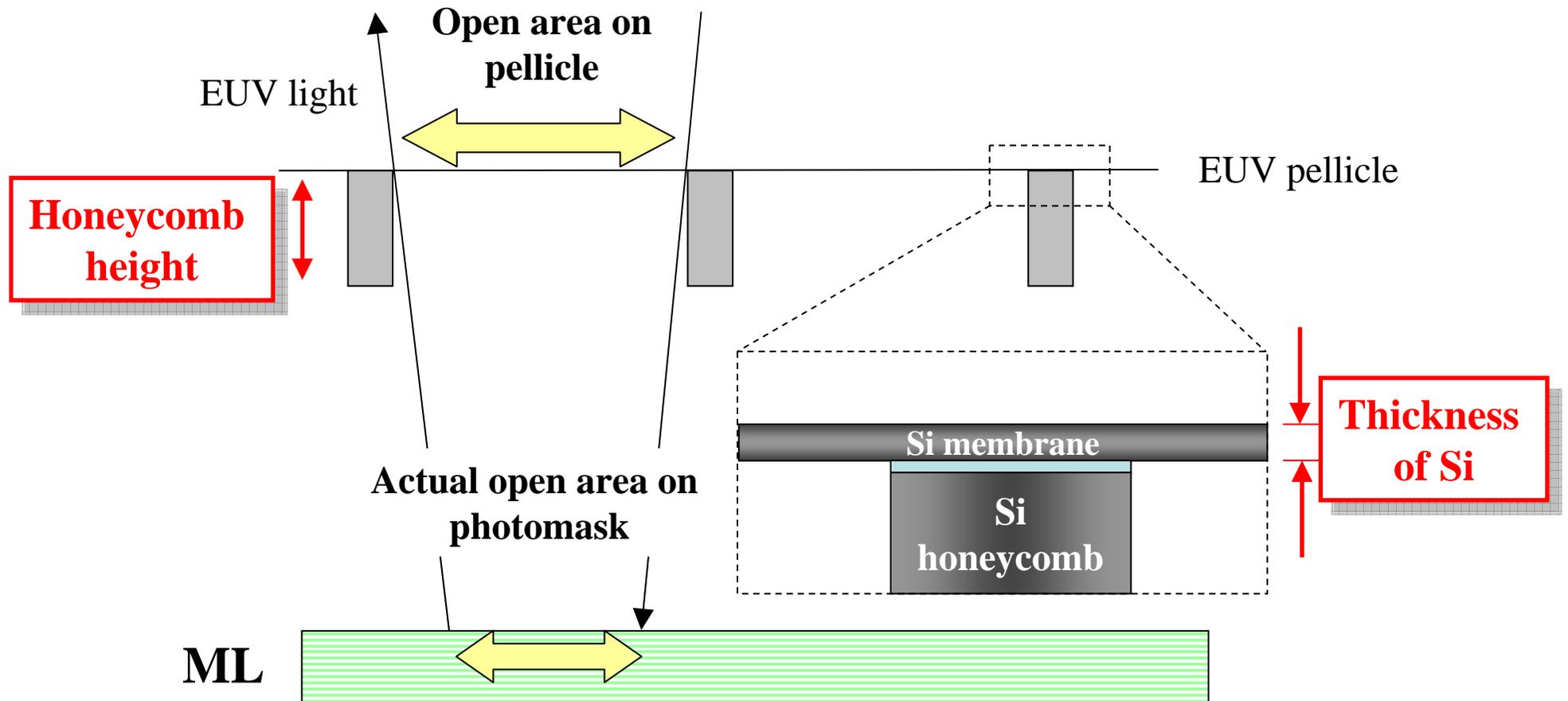


Membrane and honeycomb are made with the same material(=Single crystal Si) so that the pellicle can accommodate temperature change during continuous exposure

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Key parameters

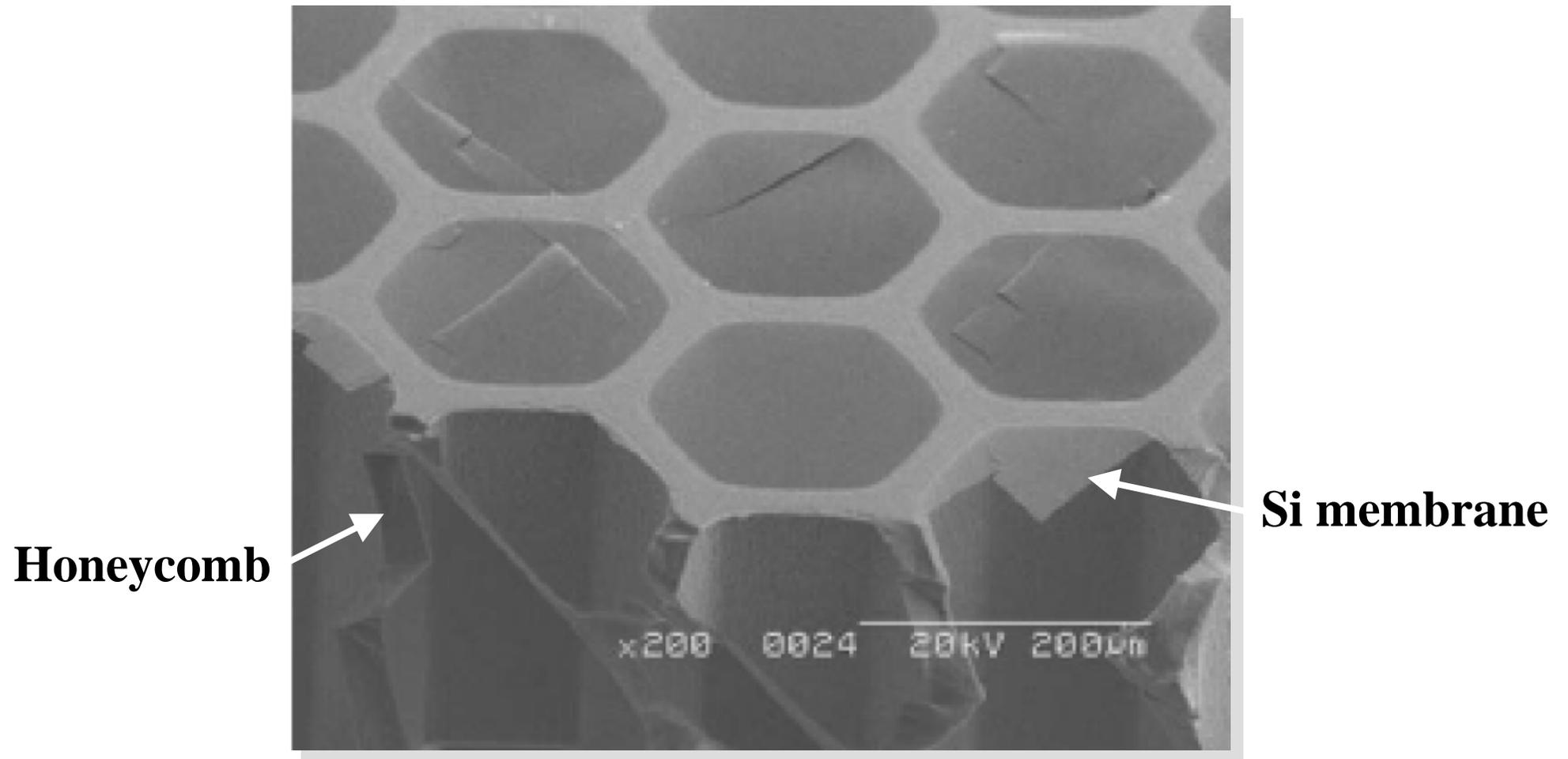


Thickness of Si membrane & Honeycomb height are the key parameters for higher transmission!

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Scanning Electron Micrograph of EUV pellicle

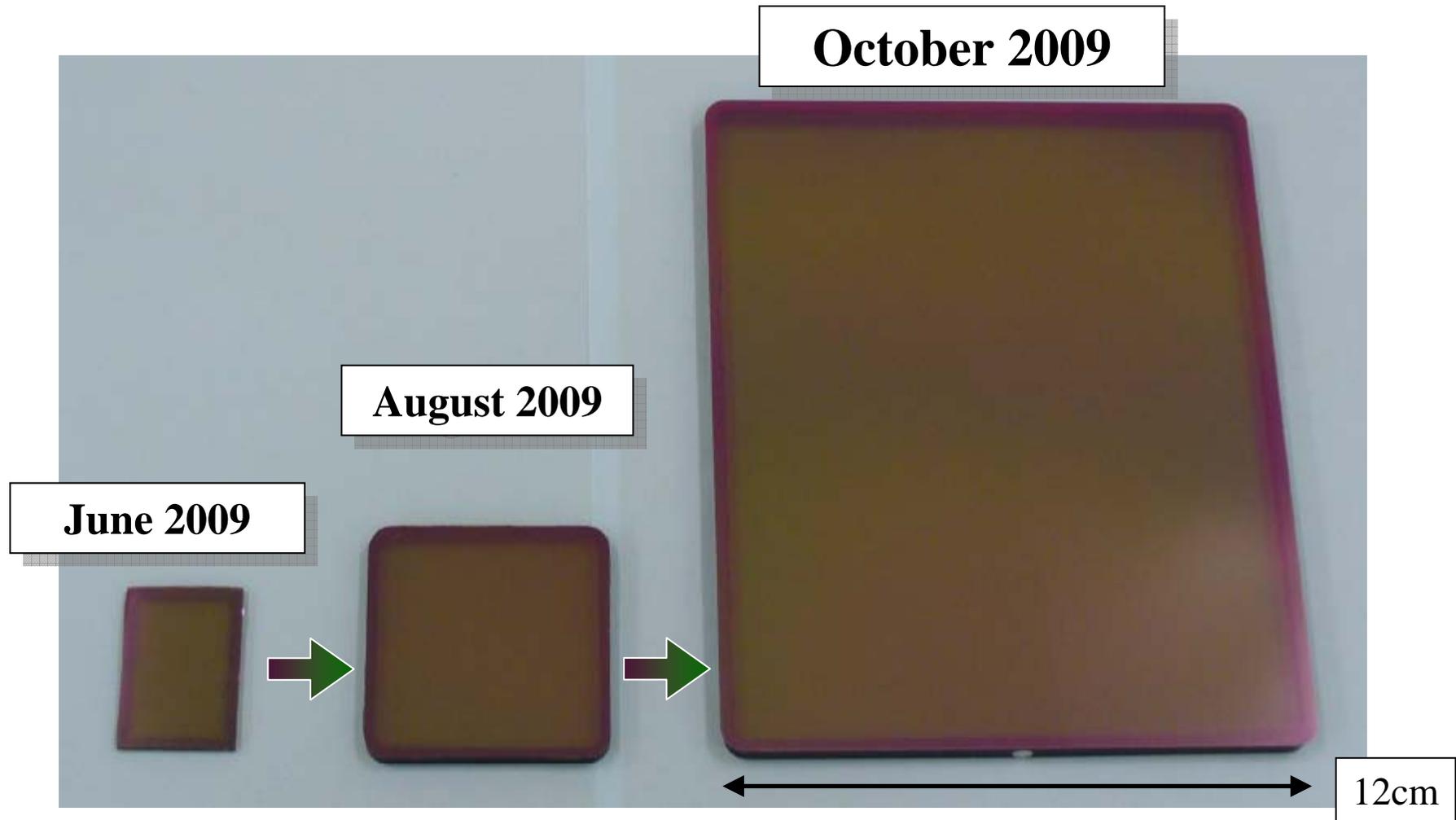


Sample was intentionally broken for SEM observation

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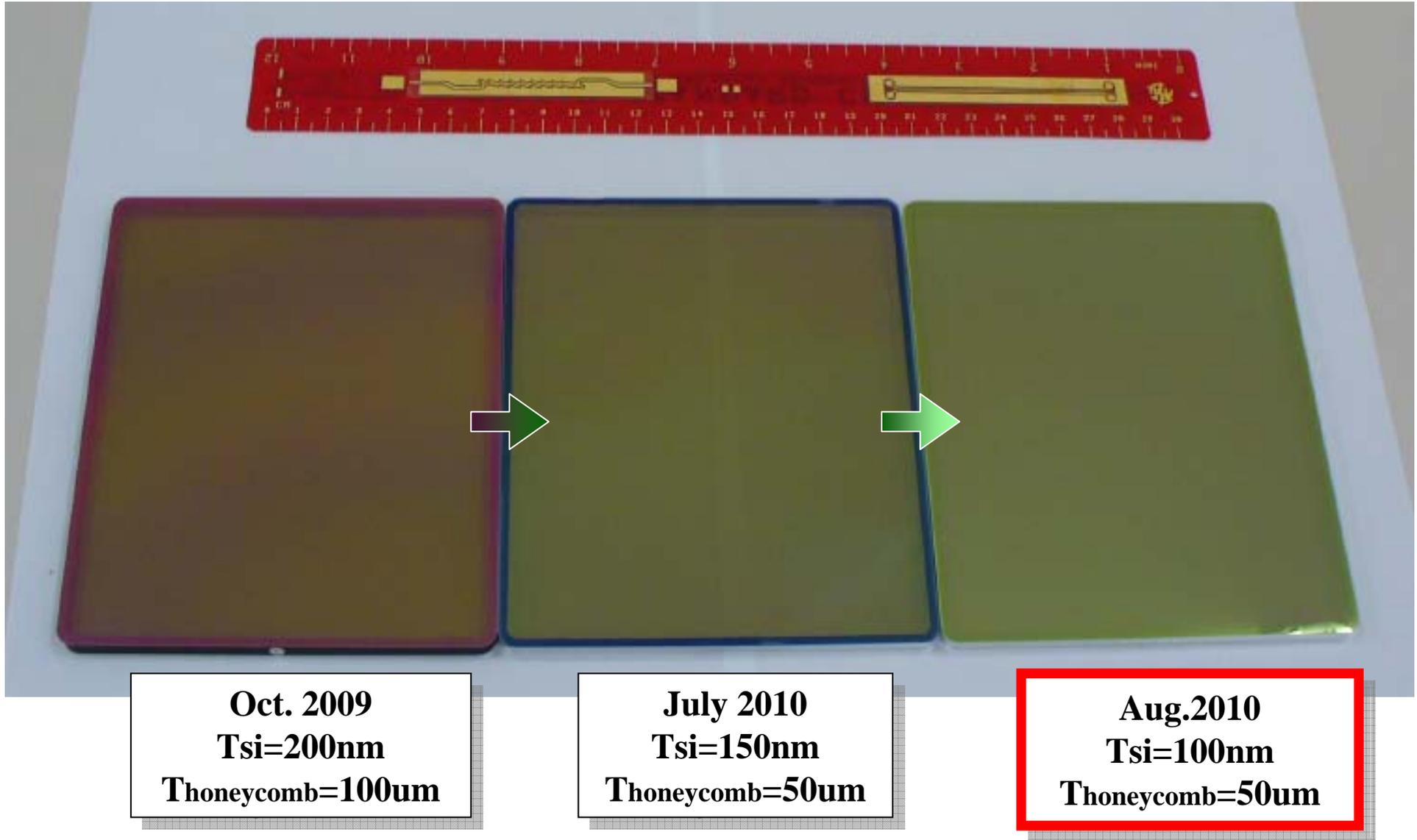
Size evolution



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Thickness reduction of Si membrane



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Stress control of membrane

Where thickness of Si membrane is 100nm

Reflected image of ceiling



Stress optimization
NOT APPLIED

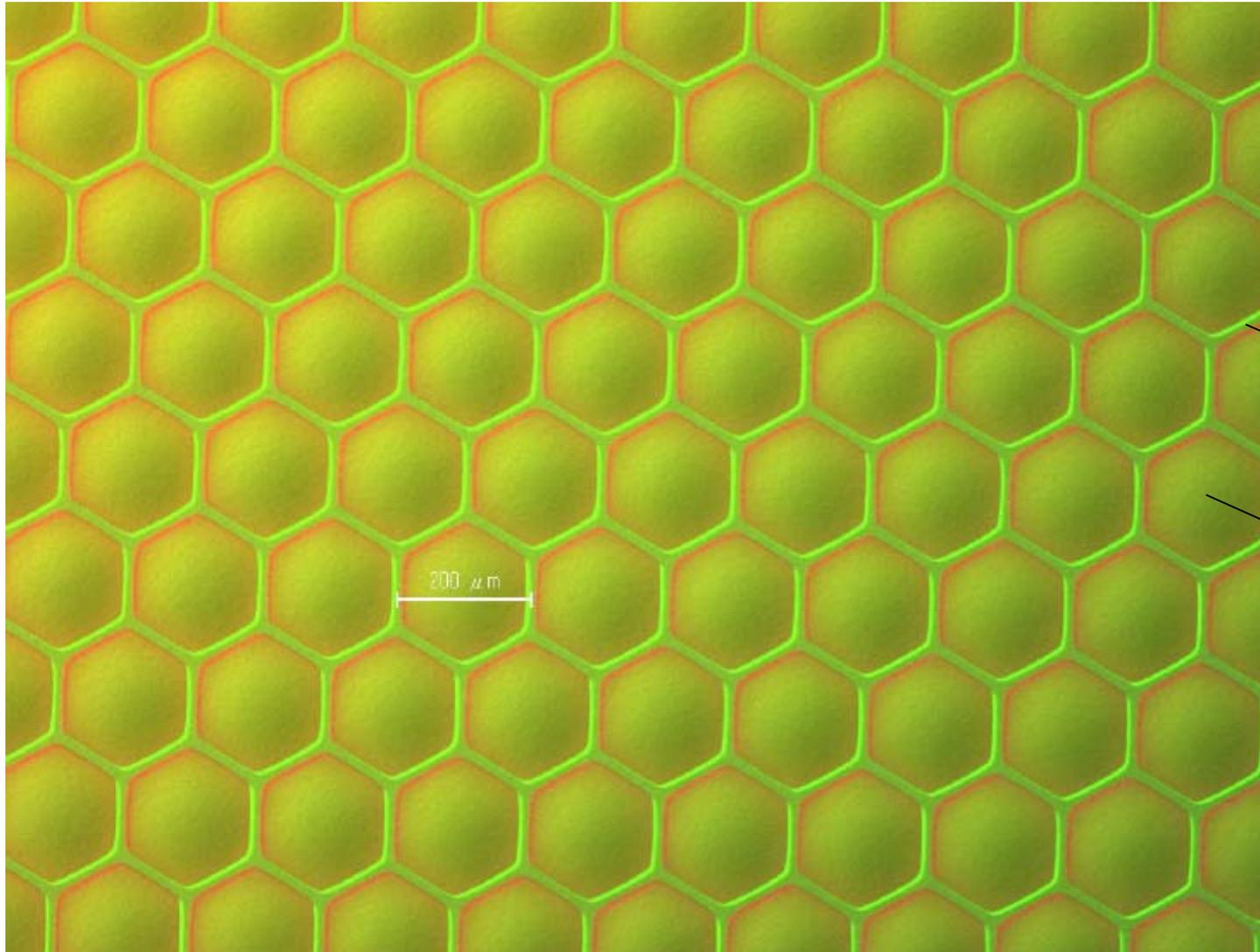


Stress optimization
APPLIED

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Optical Microscope View



honeycomb

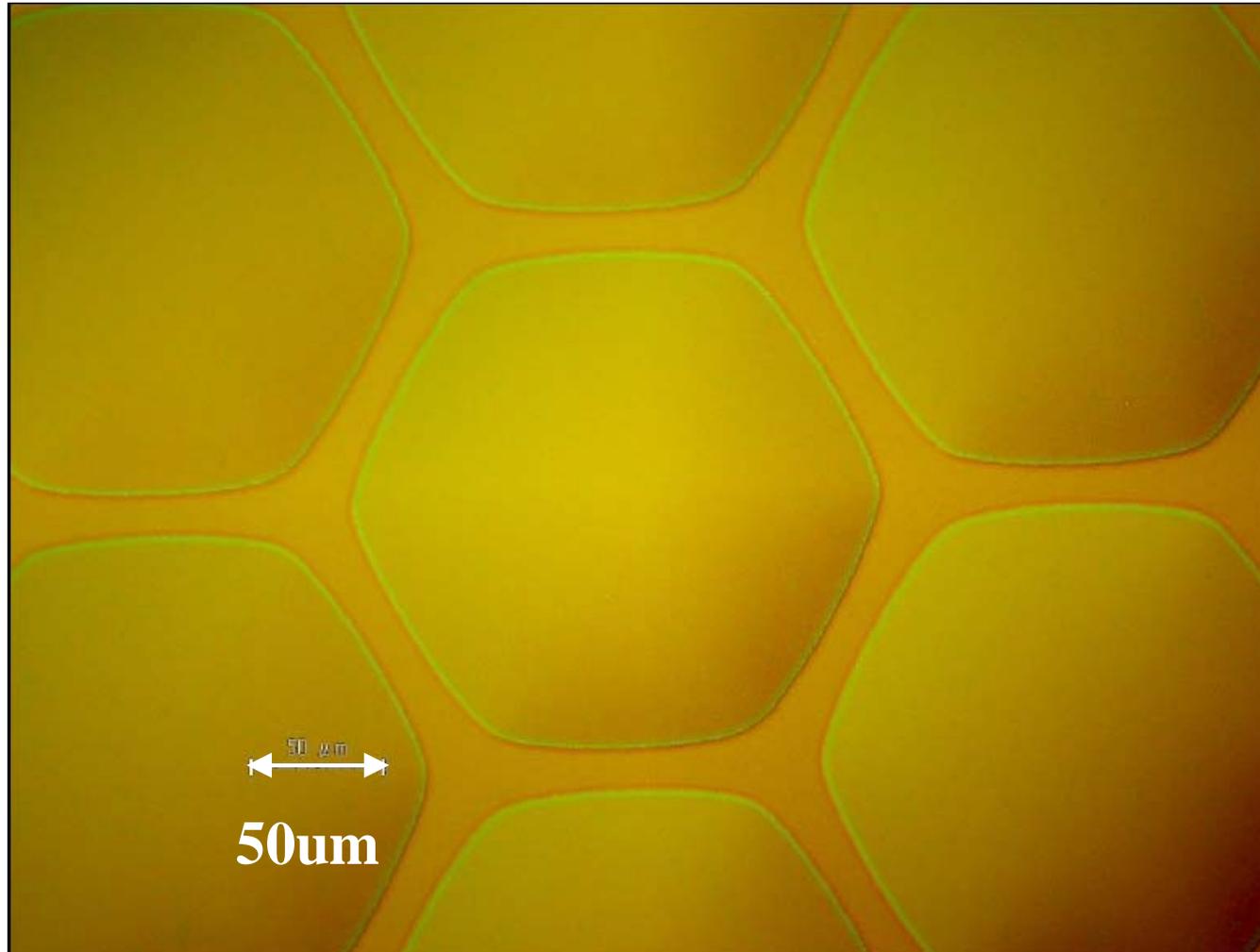
Single crystal
Si membrane

Open area
=87%

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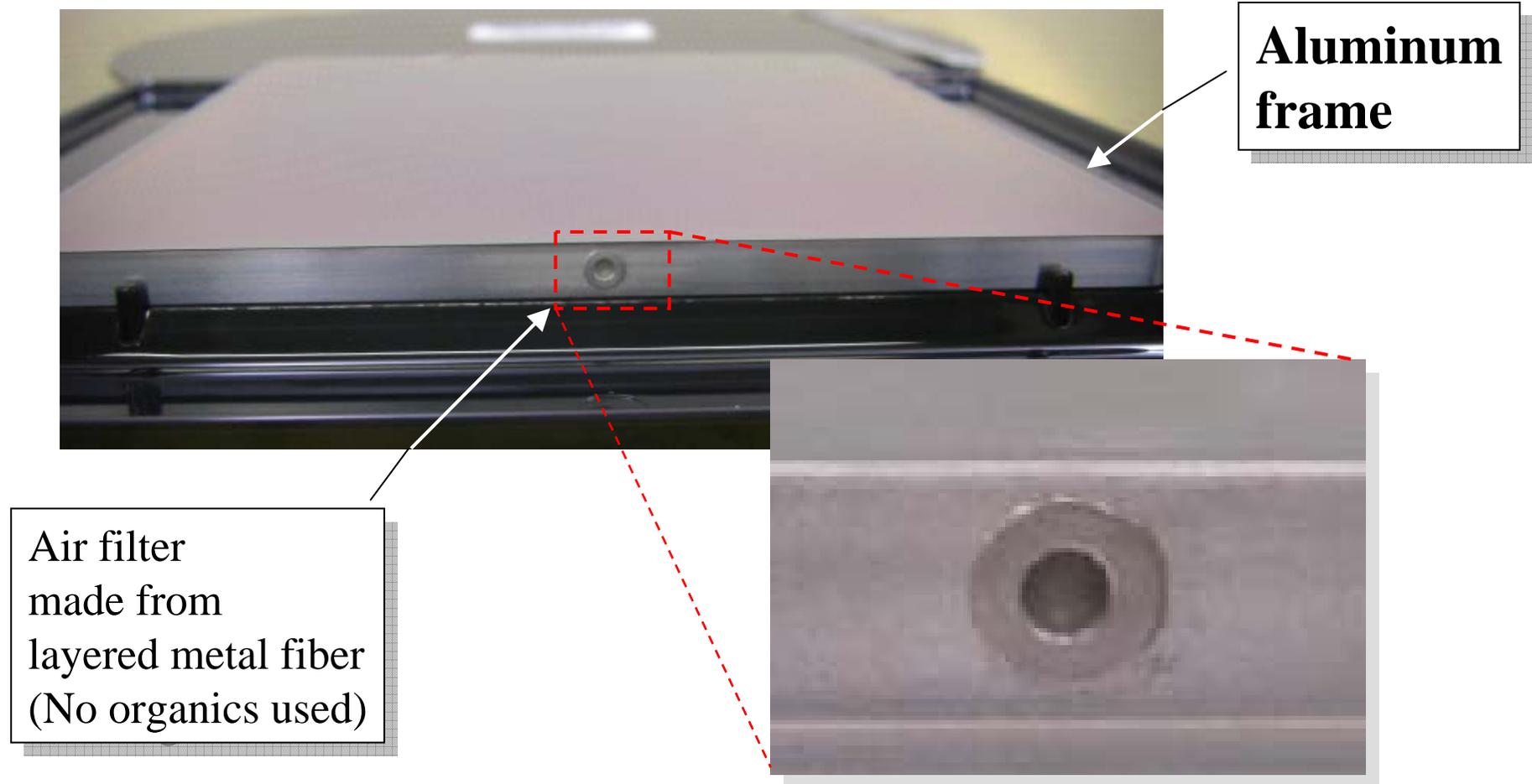
Optical Microscope View



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EUV Pellicle frame with air filter



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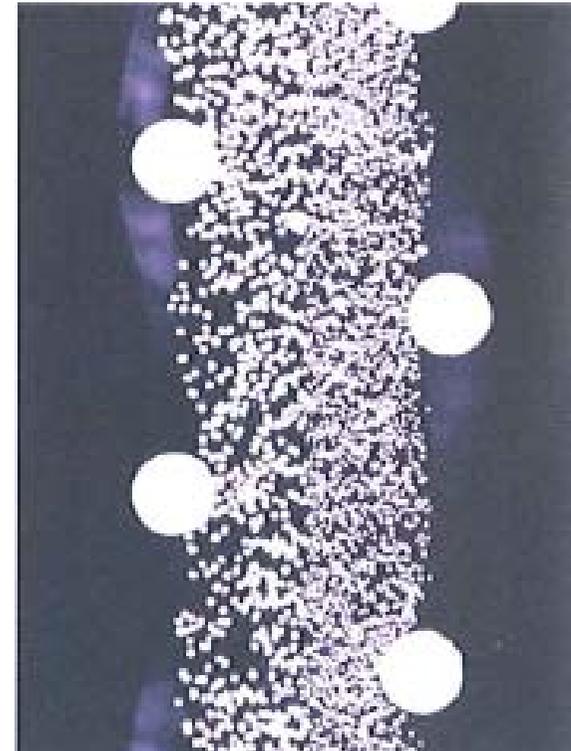
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Metal Air Filter on Pellicle Frame

Front View



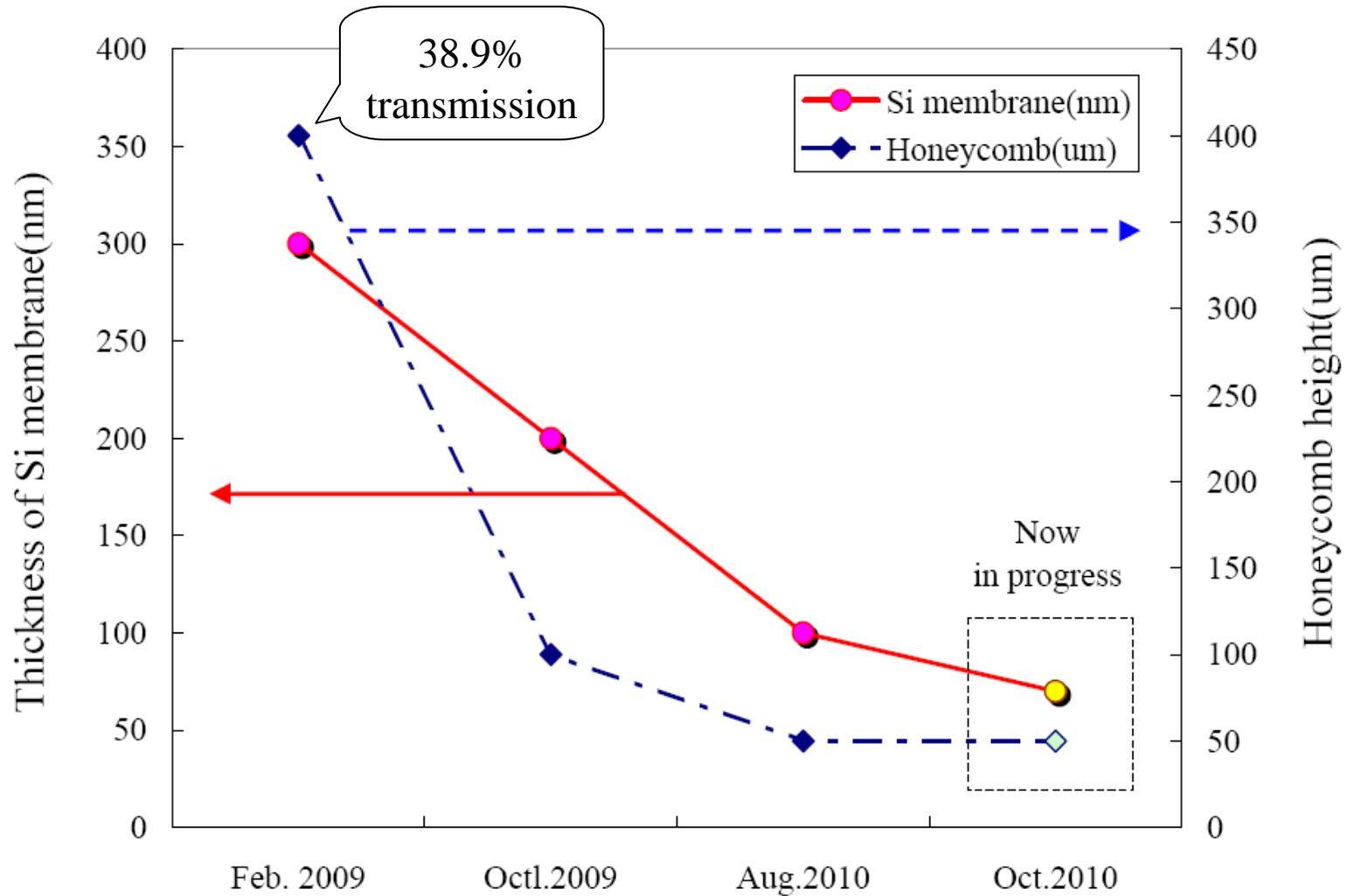
Cross section



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History of prototyping



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Summary

- Shin-Etsu EUV pellicle was demonstrated.
- EUV Pellicle with single crystal silicon membrane was realized using mature CMOS technology
- Pellicle frame with air filter was first proposed.

Future Plan

- Achieve higher transmission
- Discuss with EUV community on how to incorporate EUV pellicle into existing or future scanning tools
- Check the mechanical strength
- Achieve acceptable uniformity across the pellicle.

Contact

If you have any question, please contact @



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謝謝。 Thank you. ありがとうございます。 감사합니다 , Danke, Gracias, Merci, C n a c u b o

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