

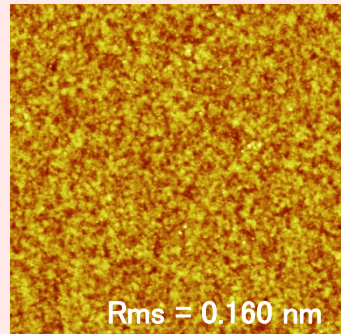
# Evaluation of the interfacial structure of a SiO<sub>2</sub> thin film on a Si substrate

The physical and chemical structure at the interface of SiO<sub>2</sub> thin films is known to be closely related to the electrical properties of semiconductor devices. We can provide various analytical techniques (AFM, EPR, FT-IR, TEM-EELS, etc.) for the evaluation at the interface between SiO<sub>2</sub> and Si substrate.

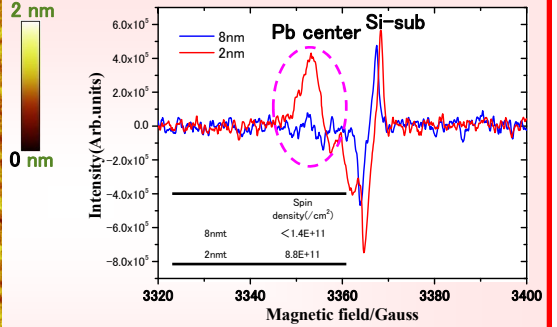
Table of analysis techniques for the oxide film

Composition	RBS, XPS
Chemical bonding	FT-IR, Raman, XPS
Sub oxide	XPS
Density	XRR
Roughness	AFM
Si-H, Si-OH	FT-IR, TDS
Thickness	TEM, ellipsometry, XRR
Interfacial layer	TEM-EELS, IR, XPS, PL
Optical constant	ellipsometry
Etching rate	ellipsometry
Defect	ESR, PL, CL
Impurity	SIMS

## Evaluation of roughness and defects at the SiO<sub>2</sub>/Si interface



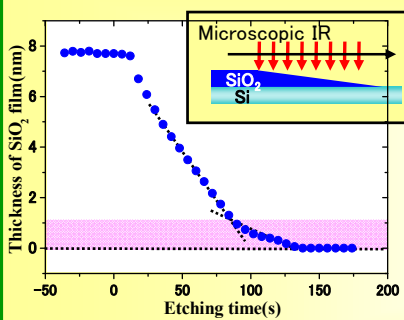
AFM image (after HF etching) 1 μm



EPR analysis to detect defects at the SiO<sub>2</sub>/Si interface

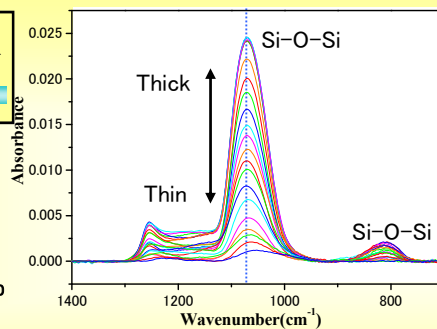
Roughness and defects at the SiO<sub>2</sub>/Si interface influence its electrical properties.

## Structure evaluation of the SiO<sub>2</sub>/Si interface by using microscopic FT-IR



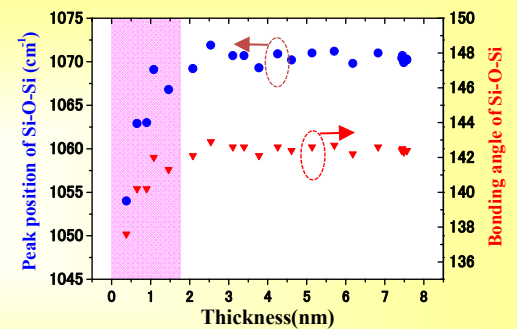
Thickness distribution on the SiO<sub>2</sub> slope

The SiO<sub>2</sub> slope was obtained using gradient etching pre-treatment. The etching rate changed at the SiO<sub>2</sub>/Si interface.



Transmittance spectra

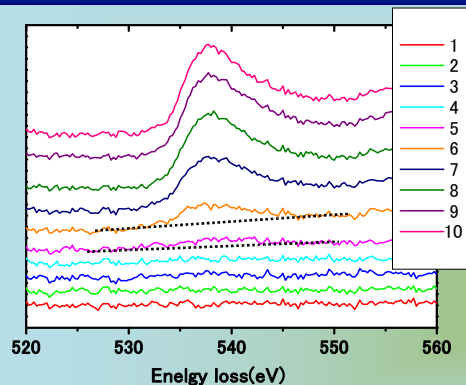
The Si-O band shifted to a lower wavenumber at the SiO<sub>2</sub>/Si interface.



The Si-O-Si bonding angle at the SiO<sub>2</sub>/Si interface

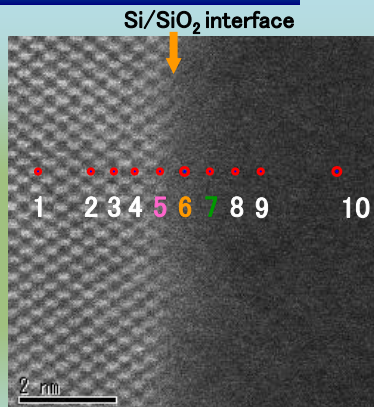
The Si-O-Si bonding angle became 4-degree smaller at the SiO<sub>2</sub>/Si interface

## Evaluation of the SiO<sub>2</sub>/Si interface by using TEM-EELS

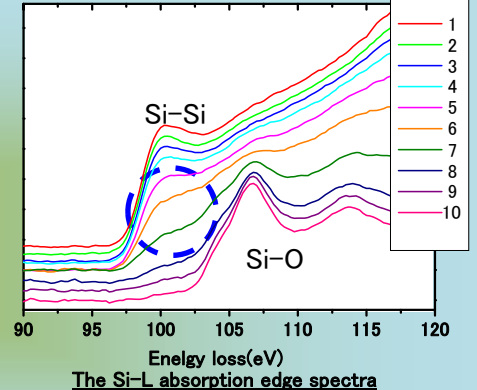


The O-K absorption edge spectra

- Oxygen has been detected at point 5.
- The peaks began to broaden at the SiO<sub>2</sub>/Si (point: 5,6) → a suboxide component may exist.



S-TEM image



The Si-L absorption edge spectra

Si-Si bonds existed in the region about 1 nm from the Si surface.  
→ the existence of Si-Si bonds might lead to the creation of suboxides and strain the Si-O-Si bond.