Thermally Stable Carbon-Doped Silicon Oxide Films Deposited at Room Temperature

1. Motivation
Low temperature deposition of silicon oxide (<100°C)
Necessary for heat-sensitive devices (device integration on flexible plastics, TFT, etc.)

Conventional
Substrate Temp.
500°C
300°C
100°C

Poor insulating properties due to OH incorporation, etc...

This Study
Room-temperature growth of silicon oxide by PECVD
✓ Remote PECVD using TEOS + Ar
  → Low temperature & low damage process
✓ Reduction of OH content by CH₃ incorporation
  → Improvement of insulating properties

2. Experimental
Remote PECVD system
Annealing
✓ 200–1000°C
✓ in vacuum (10⁻³ Pa)
✓ 1 hour

Low substrate temperature (27°C @ 50W)

Measurements
✓ XPS ✓ AFM
✓ FT-IR
✓ I–V measurements (in N₂ ambient)

3. As-grown Silicon Oxide Films
Deposition Rate
Film Composition (XPS)

✓ Smooth surface morphology (RMS~0.3 nm)
✓ Control of film composition by RF power

Chemical Bonding Structure (FT-IR)

4. Thermal Stability of the Films
Structural Change

Insulating Properties
✓ CHₙ groups: stable up to 400°C
✓ T2600°C: CHₙ reduction and OH increase → degradation of insulating properties

5. Conclusions
We have succeeded in growth of the silicon oxide with high resistivity by PECVD using TEOS at 27°C.
✓ Carbon incorporation by deposition at low RF power improved their insulating properties.
✓ CHₙ groups contained in the SiOCH films were thermally stable up to 400°C.