Semiconductor Processing:

Thermal Oxides, Defects, impurities, and diffusion

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Planar Processing with Semiconductors (Silicon): Course Map

- Crystal growth (semiconductors)
- Wafer doping (in situ)
- Wafer characteristics
- SiO₂ growth*
- Defects and impurities

- SiO₂ growth*
- Masked diffusion doping
- Lithography
- Vacuum Systems
- Thin Films: CVD, MBE, PVD, ALD
- Implantation
- Wet and Dry Etching
- Integration
Quartz and Silica
Linear rate constant vs. Temperature

\[ T \ (^\circ C) \]

- \( \text{H}_2\text{O} \ (10^5 \text{ Pa}) \)
  - \( E_a = 2.05 \text{ eV} \)

- \( \text{Dry O}_2 \ (10^5 \text{ Pa}) \)
  - \( E_a = 2.0 \text{ eV} \)

(111) Si
(100) Si

Factor of 10X
Density of available bonds in (111) and (100) faces

6.78 x 10^{14} \text{ atoms/cm}^2

7.83 x 10^{14} \text{ atoms/cm}^2
Parabolic rate constant vs. Temperature

- Wet oxidation: H₂O (10⁵ Pa) with an activation energy $E_a = 0.71$ eV
- Dry oxidation: O₂ (10⁵ Pa) with an activation energy $E_a = 1.24$ eV

Factor of 100X
Experimental SiO$_2$ thickness vs. oxidation time shows that the overall growth rate is greater for the *wet* process.

### Dry

- Highest Quality: Must take care to avoid H$_2$O contamination.

### Wet

- Poorer Quality: More porous, OH bonds block O bridges.
Optical interference

Constructive interference

Interference fringes in soap

http://en.wikipedia.org/
Transmission electron microscopy

www.tf.uni-kiel.de

vi.wikipedia.org