

Electron microscope should be a workstation rather than an imaging tool only.



Hitachi ETEM Is a “Hot” Workstation

In Situ Heating, Gas Environment, Atomic Resolution TEM

Why Environmental TEM (ETEM)?

To Mimic processes in the Real World

Example: Catalysis

- Worldwide impact of Catalysis: > 10 trillion USD/year
- 90% of chemical processes use catalysts
- 15% of GDP in industrialized countries depends on catalysts.

(1) Hitachi 100-300 kV H-9500 LaB₆ Gas Environmental TEM



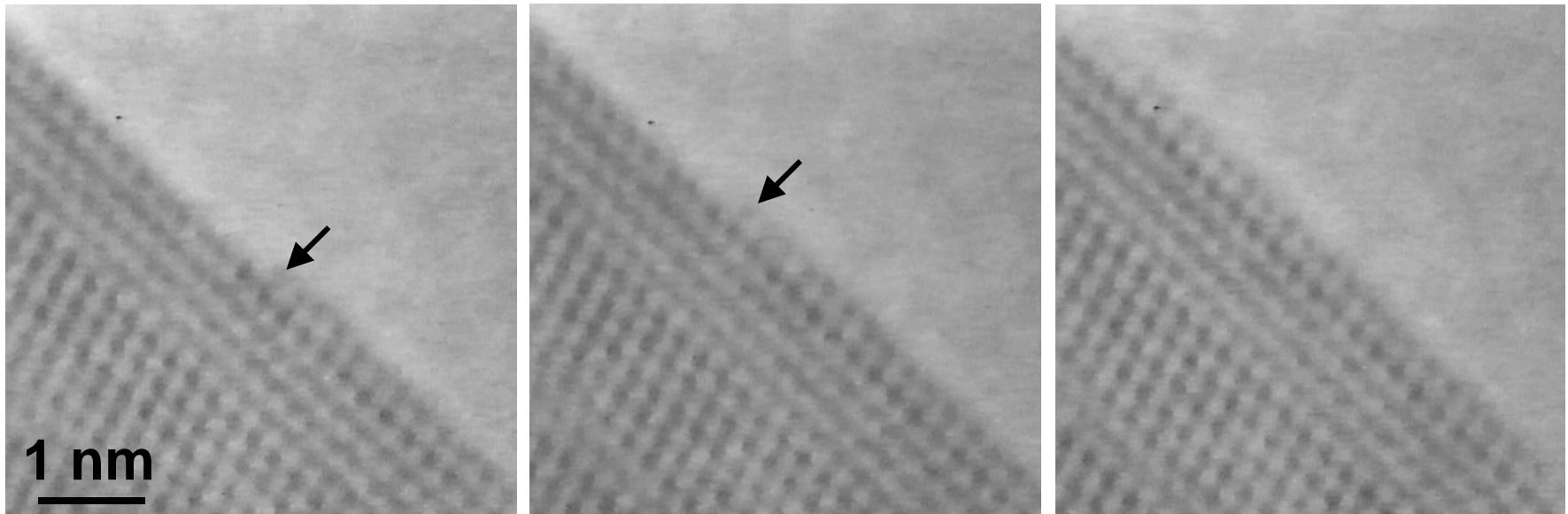
- Can accommodate **gas** in specimen chamber (gas ETEM).
- Can heat materials up to **1500°C**.
- **Atomic resolution** in situ ETEM @ high T.

Graphite @ 1000°C



Si Particles on Graphite - Atomic resolution study of SiC growth

1500°C, atomic resolution imaging for dynamic structural change



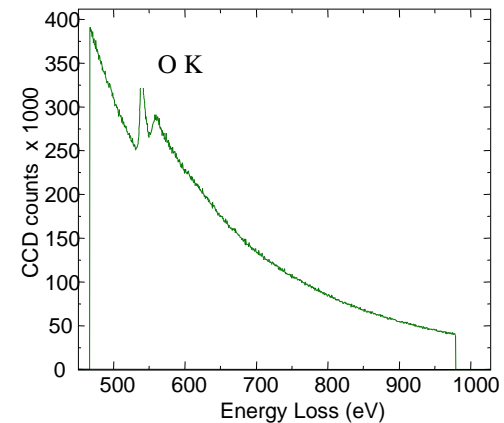
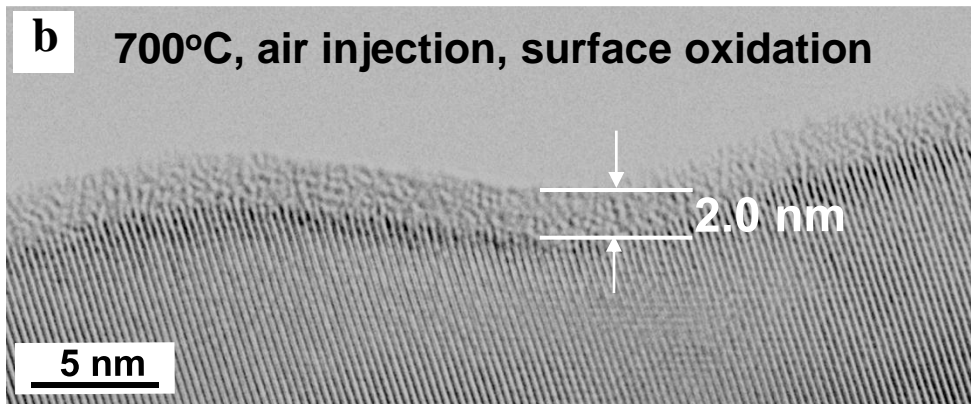
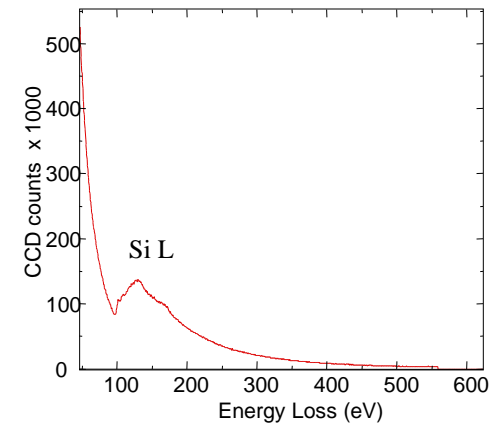
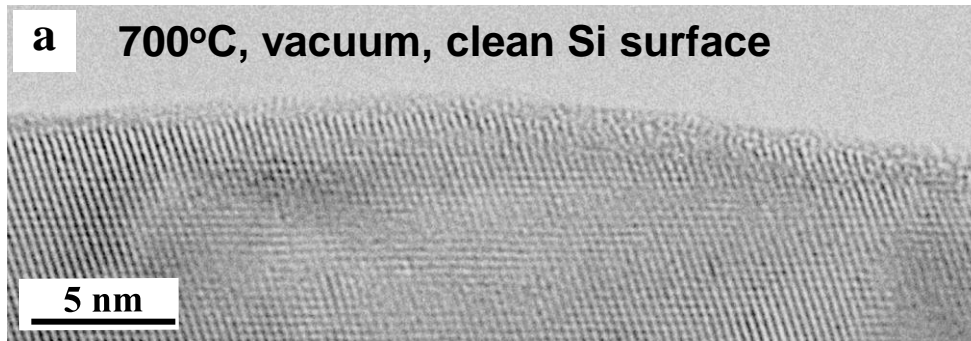
T. Kamino et al., Hitachi High Technologies, Japan

Hitachi H-9500 ETEM Triples What One Can Do

1. In-situ vacuum TEM
2. In-situ gas environment TEM (ETEM)
3. Routine TEM

Application Example for In Situ Heating Gas ETEM

Atomic resolution study of Si oxidation



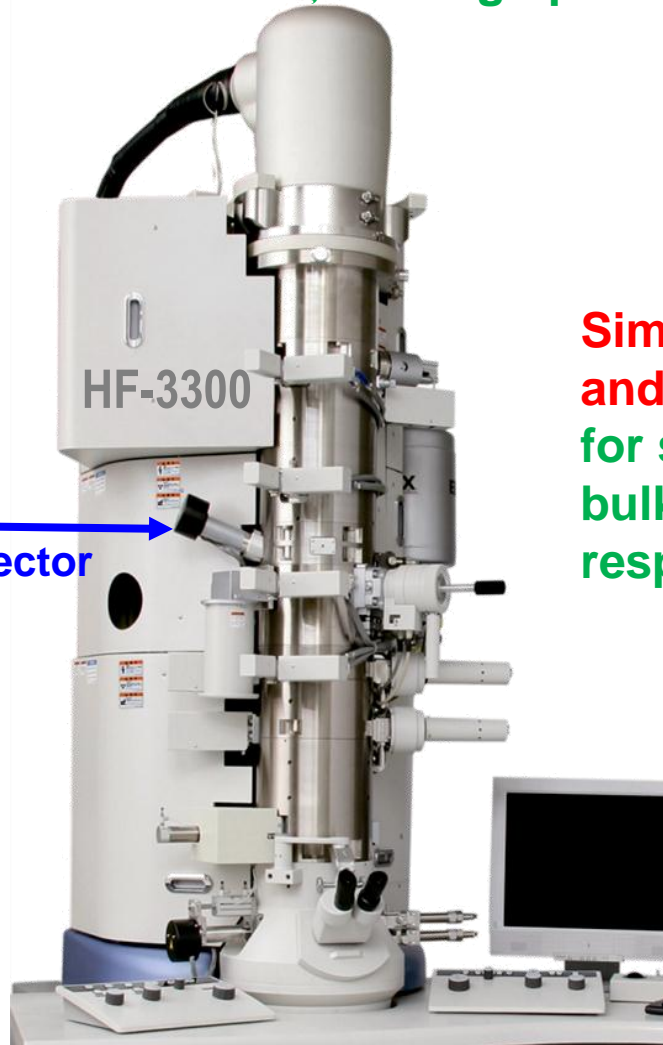
(Joint research, Hitachi High Technologies-Nagoya University-Toyota, Japan)

EELS spectra obtained from the oxidized Si surface area

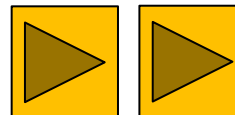
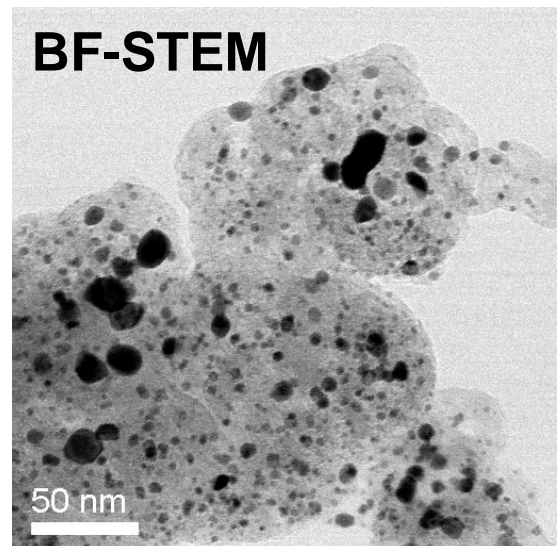
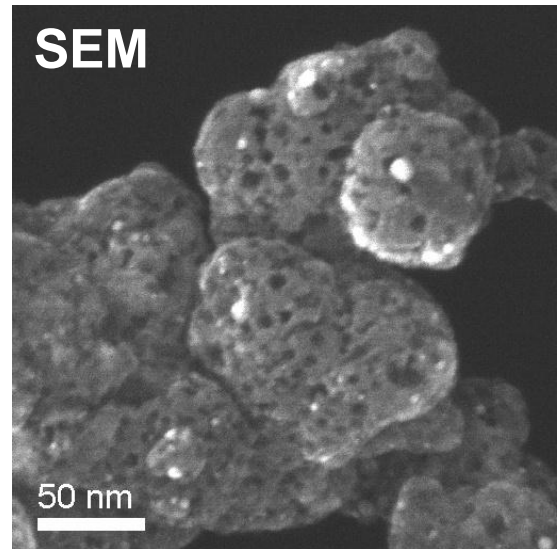
(2) Hitachi FEG Gas Environmental TEM/STEM/SEM

HF-3300, 80-300 kV, gas accommodation in specimen chamber, heating up to 1500°C

In situ heating of Pt/C



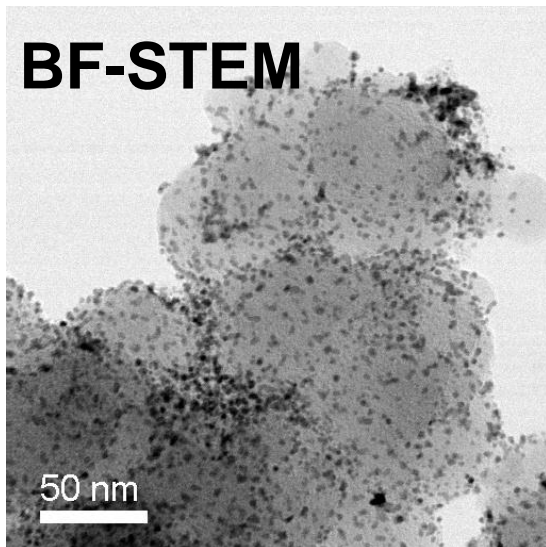
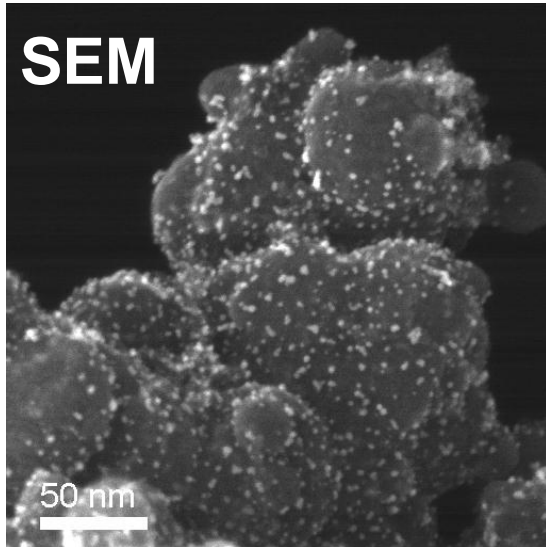
Simultaneous SEM
and STEM imaging
for surface and
bulk structures,
respectively



Click to
play movie

Pt/C catalyst, SEM/STEM, 200°C, Vacuum and Air

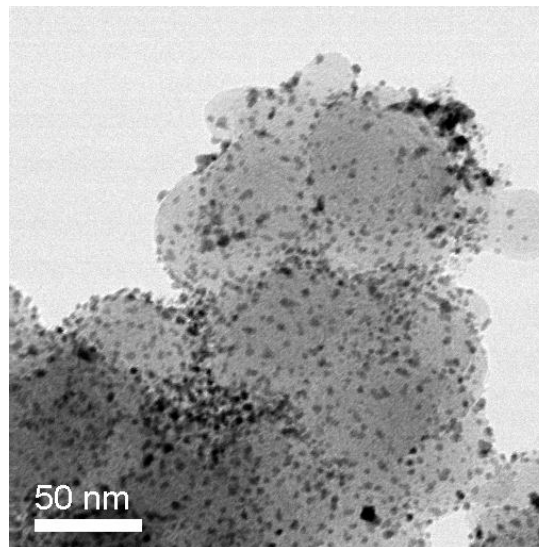
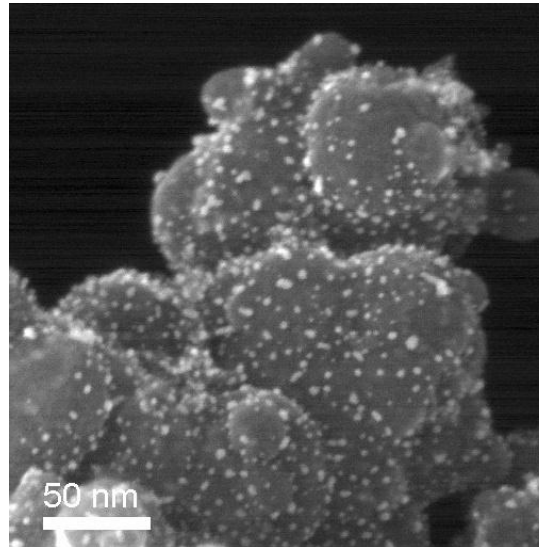
25°C, Vacuum



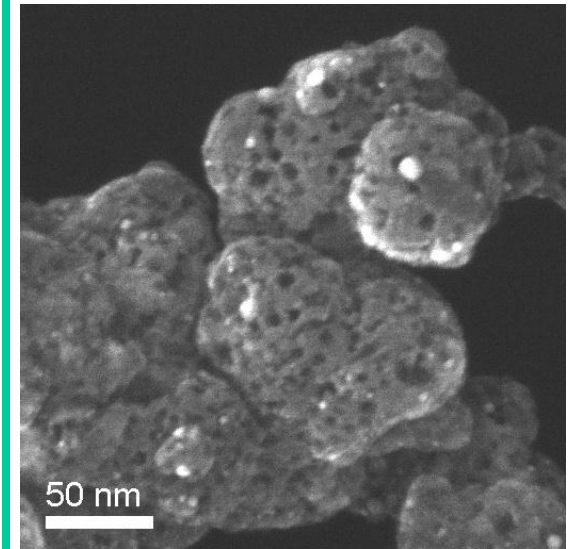
Simultaneous



200°C, Vacuum



200°C, Air



Surface reaction takes place on carbon surface with air injection, resulting in formation of holes. Nothing happens in vacuum.

Who Need H-9500 or HF-3300 Gas Environmental TEM?

Any business or research which involve solid-gas interactions and/or at elevated temperatures

- Catalysis, batteries, fuel cells
- Growth of nanomaterials and crystals
- Gas sensors
- Annealing effects, high temperature materials
- Phase transformations, structural modifications
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