Wafer Carrier Evaluation with the kSA Emissometer

Darryl Barlett
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CS Mantech
• Founded in 1992
  – Headquartered in Dexter, MI USA
  – Advanced thin-film and wafer characterization products for use with MBE, MOCVD, CVD, PVD, sputtering and evaporation systems
  – Staff of physicists, optical engineers, and software specialists

• Products
  – Wafer/Film Temperature Measurement
  – Analytical RHEED and Surface Imaging
  – Thin Film Stress, Bow, and Curvature
  – Film Thickness, Deposition Rate, Optical Constants
  – Semiconductor Optical Band Gap
  – In situ and Ex Situ Mapping Systems
  – Photovoltaic Metrology
  – Wafer Carrier Characterization
Wafer Carriers/Susceptors

- SiC coated Graphite
  - Holds wafers in MOCVD reactors
  - Transfers heat to wafers

- Requirements
  - Consistent manufacturing carrier to carrier to ensure reproducible production process (RUN to RUN and REACTOR to REACTOR)
  - Consistent manufacturing across a single carrier to ensure production uniformity (RUN YIELD)
  - Clean and bakeable for repeat use (REDUCE COSTS)

*Is there a way to determine if these requirements are being met?*
Wafer Carrier Variations

Wafer Carrier/Susceptor variations can cause:

• **Wafer temperature non-uniformity**
  – Emissivity variation caused by:
    • Varying surface roughness/morphology
    • Defects in SiC
    • Inhomogeneous SiC material quality
    • Surface nodules (small surface particles)
    • Residual material after bake

• **Epi-layer contamination**
  – Carbon outgassing from microcracks

*Wafer carrier temperature maps measured in situ using the kSA ScanningPyro.*

**Solution: Automated Measurement of Carrier Emissivity and Reflectance**
Carrier Reflectance and Emissivity

kSA Emissometer

Diffuse Reflectance

Specular Reflectance

Emissivity

Wafer Carrier Evaluation with the kSA Emissometer
Emissivity and Temperature

Emissivity

Expected Temperature

Wafer Carrier Evaluation with the kSA Emissometer
Wafer Carrier Evaluation with the kSA Emissometer
kSA Emissometer Benefits:

- Automated, fast process control
- Out-going quality certification
- Quality control tracking with end user feedback

Who Benefits?

Carrier/Susceptor Manufacturers
- Incoming quality certification
- Multi-vendor comparisons
- Better end user support

Reactor Manufacturers
- Out-going quality certification
- Quality control tracking with end user feedback

Epi Houses
- In-coming quality certification
- Multi-vendor comparisons
- Improved yield
- Bake evaluation
- Carrier end of life determination
Case 1 – Epi House Post-Bake Carrier Inspection

**Microcracks**
- Thermal mismatch between SiC and graphite
- High temperature thermal cycles
- Can cause carrier implosion in the reactors
- Can cause carbon out gassing
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kSA Emissometer
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Case 1 - Temperature and Emissivity Comparison

**kSA Emissometer (ex-situ)**

![Platen Total Emissivity](image1)

- Min: 0.8748
- Max: 0.9393
- Avg: 0.8918

**kSA ScanningPyro (in-situ)**

![Platen Temperature (Degrees Celcius)](image2)

- Min: 985.9557
- Max: 1007.1299
- Avg: 1002.5286

Wafer Carrier Evaluation with the kSA Emissometer
Case 2: New Carrier Quality

All Users Benefit:

• Quality Certificate
  – Overall carrier statistics
  – Individual and cumulative pocket statistics
  – Web statistics

• Multi-vendor comparisons

• More data for QC systems
Will kSA Emissometer benefit your process?

• Do you want to:
  – Provide better Carrier Quality Reports to your customers?
  – Use quantitative data to help adjust temperature set points?
  – Use an automated approach to wafer carrier inspection to eliminate human error?

• Not sure?
  – Contact k-Space about a kSA Emissometer demonstration on your wafer carriers.