UNIVERSITY OF CALIFORNIA, MERCED
SCIF CLEANROOM FACILITY
STANDARD OPERATING PROCEDURE (SOP)
Atomic Force Microscopy (AFM) Operation (Solver NEXT or Equivalent)
Location: SE1: 153

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1. PURPOSE

To provide a standardized and safe procedure for nanoscale surface imaging and characterization using Atomic Force Microscopy (AFM), ensuring high-quality data, instrument protection, and user safety.

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2. SCOPE

Applicable to all trained users performing AFM measurements including contact, semicontact (tapping), and non-contact modes for surface imaging and analysis.

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3. RESPONSIBILITIES

- **Users:** Follow SOP and operate within approved parameters
- **Core Staff:** Maintain system and provide training
- **Facility:** Ensure environmental stability and compliance

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4. SYSTEM OVERVIEW

The AFM is a scanning probe microscope that measures surface topography using a sharp probe interacting with the sample surface.

Capabilities:
- Nanoscale topography imaging
- Surface roughness measurement
- Phase and material contrast imaging
- Force-distance measurements
- Advanced modes (MFM, EFM, etc., depending on configuration)

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5. REQUIRED SYSTEM CONDITIONS

5.1 Utilities

- AC Power (110/220 V)
- AFM controller and software operational
- Vibration-isolated table
- Stable temperature environment (20–25°C recommended)

5.2 System Conditions

- Probe (cantilever) properly installed
- Sample securely mounted
- Scanner calibrated
- Laser aligned on photodiode
- Minimal vibration and airflow disturbance

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6. SAFETY REQUIREMENTS

6.1 Hazards

- Laser radiation exposure
- Fragile probe (tip damage risk)
- Piezo scanner damage
- Electrical components

6.2 PPE

- Cleanroom gloves
- Safety glasses
- Lab coat

6.3 Critical Safety Rules

- Do NOT stare into laser beam
- Do NOT apply excessive force to scanner

• Avoid mechanical shock to system
• Do NOT touch probe tip
• Ensure proper grounding

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7. CLEANROOM PROTOCOL

• Handle samples with tweezers only
• Ensure samples are clean and dry
• Avoid dust, fibers, and residues
• Use clean sample holders
• Minimize exposure to ambient air

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8. DETAILED OPERATION PROCEDURE

STEP 1: SYSTEM PRE-CHECK

• Verify:
o System powered ON
o Software running
o Probe installed correctly
o Sample mounted securely

STEP 2: LASER ALIGNMENT

• Align laser on cantilever
• Adjust photodiode signal
• Optimize deflection signal

STEP 3: SELECT MODE

• Choose imaging mode:
o Contact mode
o Semicontact (tapping) mode
o Non-contact mode

STEP 4: APPROACH SAMPLE

- Use automated or manual approach
- Slowly bring probe toward sample
- Monitor deflection signal

STEP 5: SET SCANNING PARAMETERS

- Scan size (e.g., 1–100 µm)
- Scan rate (0.5–2 Hz typical)
- Feedback gain
- Setpoint (force/amplitude)

STEP 6: PERFORM SCAN

- Start scanning
- Monitor:
  - Topography signal
  - Feedback stability
  - Noise levels

STEP 7: OPTIMIZE IMAGE

- Adjust:
  - Gain
  - Setpoint
  - Scan speed
- Minimize noise and artifacts

STEP 8: SAVE DATA

- Save scan images
- Export data if needed
- Record in logbook

STEP 9: WITHDRAW PROBE

• Retract probe safely from surface

STEP 10: REMOVE SAMPLE

• Remove sample carefully
• Avoid contact with probe

STEP 11: SHUTDOWN

• Close software
• Leave system in safe standby condition

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9. TROUBLESHOOTING GUIDE

Issue	Cause	Action
No signal	Laser misalignment	Realign laser
No image	Improper approach	Re-approach
Noisy data	Vibration	Stabilize environment
Tip crash	Aggressive approach	Reduce speed
Poor resolution	Damaged tip	Replace probe

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10. CRITICAL DOs & DON'Ts

DO

• Align laser properly
• Use appropriate scan parameters
• Maintain vibration isolation
• Monitor scan continuously

DON'T

• Crash probe into sample
• Touch probe tip

• Operate under unstable conditions
• Use contaminated samples

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11. CONTAMINATION CONTROL

• Use clean substrates
• Avoid outgassing materials
• Keep sample stage clean
• Store probes properly

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12. WASTE HANDLING

• Dispose wipes per cleanroom protocol
• Follow SCIF waste procedures

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13. EMERGENCY PROCEDURES

• Probe crash → Stop immediately
• Laser issue → Shut down system
• System error → Abort scan
• Electrical issue → Power OFF

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14. TRAINING COVERAGE

Users are trained on:
• AFM fundamentals
• Probe handling and installation
• Imaging modes
• Parameter optimization
• Data analysis

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15. ACKNOWLEDGMENT & APPROVAL

Director Name: _____

Director Signature: _____

Date: _____

User Name: _____

User Signature: _____

Date: _____