

BATCH MANUFACTURING RECORD

STM Hydrogen Desorption Lithography Process

Batch Number:	_____	Date Started:	_____
Device ID:	_____	Target Completion:	_____
Sample:	_____	Actual Completion:	_____
Primary Operator:	_____	QC Review:	_____

Step 1: Sample Preparation & Cleaning

Operator Initials: _____	Start Time: _____	End Time: _____
--------------------------	-------------------	-----------------

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Cleaning Method	Acetone + IPA ultrasonic	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Inspection Result	No visible contamination	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Surface cleanliness	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/>	No visible contamination	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 2: Sample Loading & Pumpdown

Operator Initials: _____	Start Time: _____	End Time: _____
--------------------------	-------------------	-----------------

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Load Time	As required	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Base Pressure (Torr)	< 1x10■■	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Loadlock pressure < 5x10■■ mbar	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 3: Degas

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Temperature (°C)	200-300	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Duration (min)	30-120	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Pressure During (Torr)	< 5x10 ⁻³	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input type="checkbox"/>	Target temperatures reached	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/>	Pressure stable	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____ Date/Time: _____

Verified by: _____ Date/Time: _____

Step 4: Flash Clean

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Flash Temperature (°C)	1200 ± 50	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Flash Duration (s)	5-10	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Flash Current (A)	Per calibration	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input type="checkbox"/>	Temperature profile correct	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/>	Surface reconstructed	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

--	--

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 5: H-Termination

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Temperature (°C)	330 ± 5	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
H Pressure (Torr)	1x10 ⁻⁶	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Dose Time (s)	As required	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Dose (Langmuirs)	~ 1000 L	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Temperature 330°C ± 5°C	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/>	Uniform H coverage	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____ Date/Time: _____
 Verified by: _____ Date/Time: _____

Step 6: STM Imaging Pre-Lithography

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Scan Area (nm)	As required	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Bias (V)	Typically -2.0 to +2.0	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Setpoint (pA)	10-100	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Atomically resolved	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/>	Terrace quality acceptable	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____

Date/Time: _____

Verified by: _____

Date/Time: _____

Step 7: STM Lithography

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Pattern Design	Per device spec	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Litho Voltage (V)	6-8 V typical	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Desorption Speed	Per pattern	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓ Check Description	Pass/Fail
<input checked="" type="checkbox"/> Pattern complete	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/> Line quality good	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____ Date/Time: _____

Verified by: _____ Date/Time: _____

Step 8: Post-Litho STM Imaging

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Scan Area (nm)	Cover pattern	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Feature Measurements	Within design spec	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓ Check Description	Pass/Fail
<input checked="" type="checkbox"/> Pattern verified	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/> Dimensions within spec	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

--	--

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 9: Dopant Dosing (PH₃ or AsH₃)

Operator Initials: _____	Start Time: _____	End Time: _____
--------------------------	-------------------	-----------------

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Dopant Species	PH ₃ or AsH ₃	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Dose Pressure (Torr)	1×10 ⁻⁶ to 1×10 ⁻⁵	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Dose Duration (s)	As required	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Dose (Langmuirs)	Per design	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Dose within spec	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/>	Pressure stable during dose	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 10: Dopant Incorporation

Operator Initials: _____	Start Time: _____	End Time: _____
--------------------------	-------------------	-----------------

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Temperature (°C)	350 ± 5	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Duration (s)	60-180	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Thermal Budget Δ (°C·s)	Track cumulative	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input checked="" type="checkbox"/>	Temperature 350°C ± 5°C	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input checked="" type="checkbox"/>	Surface morphology acceptable	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____

Date/Time: _____

Verified by: _____

Date/Time: _____

Step 11: Post-Incorporation STM Imaging

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Scan Area (nm)	Cover pattern	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Pattern Visibility	Features visible	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓ Check Description	Pass/Fail
<input type="checkbox"/> Pattern still visible	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/> No major defects	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____ Date/Time: _____

Verified by: _____ Date/Time: _____

Step 12: Silicon Overgrowth - RT Phase

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Growth Temp (°C)	25 (RT)	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Growth Time (s)	Per rate	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Target Thickness (nm)	~ 7 nm	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓ Check Description	Pass/Fail
<input type="checkbox"/> Growth rate calibrated	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/> Uniform coverage	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

--	--

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

Step 13: Silicon Overgrowth - RTA Anneal

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Anneal Temp (°C)	550	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Anneal Time (s)	60	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Thermal Budget Δ (°C·s)	Track cumulative	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input type="checkbox"/>	Temperature profile correct	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/>	No delamination	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

Completed by: _____ Date/Time: _____

Verified by: _____ Date/Time: _____

Step 14: Silicon Overgrowth - LTE Phase

Operator Initials: _____ Start Time: _____ End Time: _____

Process Parameters:

Parameter	Specification	Actual Value	Within Spec?
Growth Temp (°C)	250	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Growth Time (s)	Per rate	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Total Thickness (nm)	~ 20 nm	_____	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Quality Checks:

✓	Check Description	Pass/Fail
<input type="checkbox"/>	Target thickness achieved	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
<input type="checkbox"/>	Final thermal budget acceptable	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Notes / Observations:

--	--

Completed by: _____	Date/Time: _____
Verified by: _____	Date/Time: _____

FINAL REVIEW AND APPROVAL

Review Item	Complete	Initials
All process steps completed as specified	<input checked="" type="checkbox"/>	_____
All quality checks passed	<input checked="" type="checkbox"/>	_____
All parameters within specification	<input checked="" type="checkbox"/>	_____
All deviations documented and approved	<input checked="" type="checkbox"/>	_____
All required signatures obtained	<input checked="" type="checkbox"/>	_____
LabVIEW process files linked/attached	<input checked="" type="checkbox"/>	_____
STM scan files linked/attached	<input checked="" type="checkbox"/>	_____

Final Approvals:

Quality Control Review:

Signature: _____

Date: _____

Printed Name: _____

Process Engineer Review:

Signature: _____

Date: _____

Printed Name: _____

Principal Investigator Approval:

Signature: _____

Date: _____

Printed Name: _____

This batch manufacturing record must be completed in its entirety and approved by all designated reviewers before the device can proceed to electrical testing or further processing.