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Badger name:	AV-2 Plasmatherm (k3)	Revision number:	1
Model:	Vision 320	Revisionist:	Wanjohi Kimani
Location:	Keller – Bay 3	Date:	March 30, 2020

AV Etcher 2 - Standard Operating Procedure

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1. Scope

1.1. This document provides detailed instructions on how to properly operate the AV Etcher 2.

2. Tool Description

2.1 The AV-2 Etcher is an RIE system with five (5) etchant gases available. These are: Argon (Ar), Trifluoromethane (CHF₃), Tetrafluoromethane (CF₄), Oxygen (O₂) and Sulphur Hexafluoride (SF₆). The system is designed to etch silicon, silicon nitride, silicon oxide, photoresists, other allowed organics and semiconductor materials. It is run via Cortex (for Vision) software in Microsoft Windows 7.



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3 Safety

3.1 While chamber is closing, ensure there are no items including limb in the path where the lid rests after closing.

4 **Restrictions/Requirements**

4.1 Must be a qualified user on the AV-KH Etcher

5 Required facilities

- 5.1 Compressed air
- 5.2 Chilled water
- 5.3 Vacuum
- 5.4 N₂
- 5.5 CHF₃
- 5.6 CF₄
- 5.7 O₂
- 5.8 SF₆
- 5.9 Ar
- 6 Notes
 - 6.1 The AV-2 Etcher has different etch recipes from those in AV-1 etcher or the STS etcher. Standard recipes from the older etchers were determined not to work well in the new etcher. A table with the recipe parameters and the etch rates has been included at the end of this SOP. Note that the AV Etchers utilize a graphite chuck, while the STS Etcher has an anodized aluminum chuck.

7 Operating instructions

7.1 Logging on

- 7.1.1 Enable the "AV-2 Plasmatherm (K3)" using the MNC Badger system
- 7.1.2 If login is required, select **OPERATOR** and click the **User Login** button. Enter **1234** for password.





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The screen image below is what you see when logged in

Vision 320 p10532 - U of MN	Info											Glance I/O Override ACAP		
Cortex v1.6.8	Alarm	1								Ste	art Job		Operator	No Tasks
Start Job Next Step Abort Job Pump Down	R	ecipes COZClean - STS OZClean High power OZClean Maintalinance PR Etch 10w rate) PR Etch 3 (Anisotropic) PR Etch 3 (Anisotropic) PR Etch 2 high rate) Quartz Etch Si,etch high_rate (mcgnaic mask) SiJNA - anisotropic SI3NA - anisotropic SI3NA (LPCVD) Standard	Recipe Step Info Temperatu Ele Gas CF, CHI SF, OI	re ctrode Setp 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	Setpt 20.0 t Actu 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	Actu 19.	al 9 °C sccm sccm sccm sccm sccm sccm sccm scc	RF RF F	Setpoint Reflected DC Bias IN Mode Load Tune	Loop Setpt 0.0 Auto 50.0 50.0	Actual 0.0 0.0 1.0 natic 68.0 57.0 57.0	W W V % %		
Set Recipe Set Recipe Set Standby Temps		Job Id < Enter Job Id > Auto Vent Status Idle	Pressure Pressure Throttie	Setpoin	t).0 101	Actu 0.3 m	ы л т						Pressure PM1 0.2 mT	Status Pumping Idle
Start Job Job His	story	Service					G	Back			Alarms	Help	-	

7.2 Vent and Loading samples

7.2.1 Click on "VENT" button on the left side of the screen

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7.2.2 Wait until the system is vented as indicated by the info section at the top of the screen. When vent is complete, click on **OPEN LID** and acknowledge. You can also select "**SERVICE**" at the bottom of the screen, then click **OPEN LID** to open the lid without needing to acknowledge.

Vision 320 p10532 - U of MN Cortex v1.6.8 2019-04-30 + 08:11:35	Info	Glance VO Overide ACAP Start Job	User Login Abort Operator No Tasks
Start Job Next Step Abort Job Pump Down Vent Open Lid Close Lid St Recipe Temps Set Standby Temps	Recipes Image: Colorary STS O2Clean - STS O2Clean High power O2Clean Maintainance PP Rth 1 (low rate) PP Rth 2 (Anisotropic) PP Rth 2 (Anisotropic) PP Rth 2 (Anisotropic) Quartz Etch SLetch high_rate (Romganic mask) SLetch high_rate (Romsack) SLetch high_rate (Romsack) SLetch high_rate (Romsack) Job Id < Enter Job Id > Auto Vent Status Idle Status	Recipe Loop Elapsed Step Info Image: Step Info Image: Step Info	Pressure Status PMI 7601 Vented
Start Job Job His	tory Service	Go Back	

If you are on the service menu, it should like this (below)

Vision 320 p10532 - U of MN Cortex v1.6.8 2019-02-01 + 13:52:52	Info Alarm	Glance UO Overide ACAP Mechanism	User Login Operator	Abort No Tasks	
	ī	Hoist	Presure PAL LogIO	Satut T Panging ble	
Mechanism Usa	ge				
Process		Service Service			

7.2.3 After the chamber lid lifts up, it will swing to the right and then come to a stop.

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- **7.2.4** Load your samples directly on the graphite chuck. Place glass slides along the sides of your sample(s) if you don't want your samples to shift extensively during pump down. The glass slides can be adhered to the chuck with Kapton tape.
- **7.2.5** Click on the "CLOSE LID" on the left side of the screen or in the SERVICE menu. The chamber lid should now close automatically.
- 7.3 Running a process

Vision 320 p10532 - U of MN	Info						Glance I/O Override ACAP	<u>8</u>		
Cortex v1.6.8	Alarm					Start Job		User Login Operator	Abort No Tasks	
Start Job Start Job Next Step Abort Job Pump Down Start Job Vent Close Lid Start Recipe Cost Standby	Rec J	ipes Q2Clean - STS Q2Clean High power Q2Clean Maintainance PR Rtch 1 (wo rate) PR Rtch 1 (wo rate) PR Rtch 2 (high rate) Quartz Etch SLetch high_rate (incrganic mask) SLetch h	Verieble Time Steps Verieble Time Steps Recipe College College Main Steps # Name 3 ETCH	pe for a constant of the const	Duration 2000	New Duration		Pressure PM1 0.1 ml	Status Purnping Idle	
Start Job Job His	tory	Idie	Pressu Thrott	ure 0.0 mT 0.1 mT ttle 0.0 100.0 %						

- 7.3.1 After closing the lid, click on the **AUTO VENT** box if you want the system to vent automatically upon completion of the job.
- 7.3.2 Click on "START JOB" to run a process.
- 7.3.3 Enter the duration of etch in min and seconds (see diagram above)
- 7.3.4 Click **START PROCESS**
- 7.3.5 The process will begin automatically. Gas flow and chamber pressure will stabilize, and then RF will turn on and ignite plasma. A process countdown timer is displayed on the top right side of the screen (as well as the feedback for the gas flow, pressure, power, etc). When the programmed step is complete, plasma will extinguish, process will end automatically and place the system in standby mode (if **AUTO VENT** is not checked) or vent to atmosphere (If **AUTO VENT** is checked)

Vision 320 0532 - U of MN Cortex v1.6.8	Info Processing.			I/O C	CAP User Login	Abort
9-04-30 • 08:15:55	Alarm			Start Job	Operator	1 Task
	🔶 O2Clean Maintainance	Recipe O2Clean Maintaina	nce	Loop Elapsed		
	1) < Initial >	Step Info ETCH	3 of 5	0:14.1 / 5:00.0		
Start Job	3) ETCH	Temperature	RF			
	4) Evac Step	Setpt Actual				
Next Step	5) < Eliu >	Electrode 200 200 °C	RF	Setpt Actual		
		Electrode 200 C	Setpoint	100.0 100.0 W		
Abort Job		Gas Setpt Actual	Reflected	0.0 W	<u>_</u>	
		CF4 0.0 0.0 sccm	DC Bias	331.0 V		
		CHF3 0.0 0.0 sccm	AMN Mode	Automatic		
Rumo Down		SF6 0.0 0.0 sccm	Load	50.0 73.0 %		
Pump Down		Ar 0.0 0.0 sccm	Tune	50.0 58.0 %		
Vent	Job Id O2Clean Maintainance					
Open Lid	Auto Vent				Pressure	Status
					PM1 20.0 m	T Processing
Close Lid						
Set Recipe						
Temps	Chalue -	Pressure				
Set Standby	Processing.	Setpoint Actual				
Temps	. rocessing	Theotile 00 136 %				
		110000 000 1000 16				
	,					
t Job Job Hist	ory					

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Note that if you want to abort the process before the timer goes to "0", you can press the "**NEXT STEP**" button on the left side of the screen.

7.4 Unloading samples

- 7.4.1 Click on "**VENT**" button on the left side of the screen (assuming system did not vent automatically)
- 7.4.2 Once the system is vented, click "**OPEN LID**' and acknowledge or open the "**SERVICE**" menu at the bottom of the screen and then click on "**OPEN LID**"
- 7.4.3 After the chamber lid lifts up, it will swing to the right and then come to a stop.
- 7.4.4 Unload your samples
- 7.4.5 Click on the "**CLOSE LID**" button. The chamber lid should now close automatically.
- 7.4.6 Click on the "**PUMPDOWN**" button situated on the left side of the screen

7.5 Logging off

- 7.5.1 On the upper-right side of the screen, click on "USER LOGIN", then click on "LOG OUT".
- 7.5.2 Disable the "AV-2 Plasmatherm (K3)" using the MNC Badger system.

8 Trouble shooting

- 8.1 If you try to start a job while the lid is open, the tool will go into alarm. Simply click on "ALARM" at the bottom of the screen, and look for the "SILENCE" button. Then close the lid and start the job.
- 8.2 Should the system not function as intended, report problem on Badger and/or contact MNC staff responsible for the tool.

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9 Process parameter table

			Gases					
	CHF3	CF4	SF6	02	An	Pressure	Power	Platen Temp
Etch Recipes		Gas	flow (so	cm)		mT	watts	۰c
FastPoly			25	4		80	100	20
O2Clean Maintenance				99		100	150	20
O2Clean STS				99		100	100	20
O2Clean high power							300	20
Photoresist etch - 1 (low rate)				99		50	150	25
Photoresist etch - 2 (High rate)				99		100	300	25
Photoresist etch - 3 (anisotropic)				10		13	200	20
PJSOxide	25	12.5			25			
Si_3N_4 (LPCVD) etch - Selectivity to oxide			20			40	50	25
Si ₃ N ₄ (LPCVD) etch - standard	10	42				80	150	25
Si ₃ N ₄ etch - anisotropic (TYB type)	25	10				50	150	25
Si etch - high rate (PR mask)	7.5		19.5			30	55	20
Si etch - precision (NIT1 type)		32		8		80	100	20
SiO ₂ etch - PJSOxide type	25	6			25	50	175	25
SiO ₂ trench etch			20			40	200	30
NB Etch - (72 CF4:8 O2)		72		8		150	100	20

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10 Process etch rates

	Target material	Target's etch rate		Typical masking materials												
		measured (MNC)	AZ 1512	(+ve PR)	NR 71 1500P (- ve PR)		SiO ₂ (Thermal)		Si3N4 (LPCVD)		Oxide (Oxide (PECVD)		41203	Silicon Eta ma	ch with PR 2sk
Etch Recipes		(Å/min)	(Å/min)	Unif(±)	(Å/min)	Unif(±)	(Å/min) Unif(±)		(Å/min) Unif(±)		(Å/min)	Unif(±)	(Å/min) Unif(:		(Å/min)	Unif(±)
FastPoly	Si														22,600	
O ₂ Clean Maintenance	NA		1359	4.6%			15.6	66.5%			1.5		2.6			
O2Clean STS	PR (AZ 1512)	1,625	1110	1.5%			(0.4)				10		0			
O2Clean high power	Chamber		4716	7.2%			0.2				3.5		0.4			
Photoresist etch - 1 (low rate)	PR (AZ 1512)	2,370	2370	3.9%	2042	23.1%	(0.8)				1.5		0.7			
Photoresist etch - 2 (High rate)	PR (AZ 1512)	5,057	5057	6.1%	4269	4.0%	(0.1)				0.1		0.5			
Photoresist etch - 3 (anisotropic)	PR (AZ 1512)		1529	3.6%			4.0				5.4		4.9			
PJSOxide	SiO2		49.1	20.2%												
Si_3N_4 (LPCVD) etch - Selectivity to oxide	si ₃ N ₄	260	206	4.6%			78	13.3%	260	19%	79	10.6%	0.4			
Si ₃ N ₄ (LPCVD) etch - standard	si ₃ N ₄	360*	194	9.7%	259	23.1%	310	4.6%	388	26%	320	11.3%	3.1			
Si ₃ N ₄ etch - anisotropic (TYB type)	Si ₃ N ₄	38					221	17.6%	38	90%	215	7.2%	3			
Si etch - high rate (PR mask)	Si	3,233	267	6.6%	323	19.2%	134	12.4%			117	19.6%	(1.4)			
Si etch - precision (NIT1 type)	Si	3,899	709	5.6%			322.0	9.4%			1143	8.3%	0.5			
SiO ₂ etch - PJSOxide type	SiO ₂		19		74	88.4%	284.0	6.4%			271	19.80%	2.9			
SiO ₂ trench etch	SiO ₂		1907	3.9			779	4.7%	847	16.8						
NB Etch - (72 CF4:8 O2)	Niobium						245	33.7%	579	17.5%	267	15.10%				