SiM : STM iMproved

*nano*REV™ Specification Sheet
Version 7.x Vacuum STM

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Cover Image: Royal Poinciana (Delonix Regia), popularly known here as the Gulmohar tree is a flamboyant flaming tree blooming in the summers, a sheer delight to the eyes in an otherwise scorching city heat. It is such a wonderful tree, but its numbers are dwindling in the Capital, we would love to see them flourishing always!

S1 Electronics

	Features	Description
1	Main Power Supply Input[1]	220-240V AC/50 Hz, 15 W.
2	Power Supply outputs	+5V DC, ±15V DC, ± 110V DC, 110V AC.
3	Computer Interface	USB 2.0 Port.
4	Measurement Channels	8-channels, 16-bit simultaneous sampling ADC.
5	Scan generator	8-channels, 16-bit D/A converter.
6	Scan speed	Upto 77ms/line (13Hz) for 256 pixel scan and retrace image.
7	Scan drive signals	±100V DC.
8	Slope compensation	Digital horizontal and vertical slope compensation.
9	Tunnel Current Set Point Adj.	±80nA in steps of 3pA.
		±10nA in steps of 0.3pA (Optional)
10	Servo Control	Digital Feedback Parameter (Gain, Time Constant) Adjustments.
11	Walker Display	LCD Display of piezo-electric walker's direction and no. of steps.
12	Bias Settings	-10V to +10V in Steps of 0.3mV,
		-100V to +100V in Steps of 3mV.
13	Imaging modes	Topographic imaging with sub-atomic resolution in:
		- Constant Current (CC) Mode,
		- Constant Height (CH) Mode.
14	**Imaging modes with LIA[2] (Lock-in Amplifier)**	Simultaneous imaging besides topography:
		- Local Density Of States (LDOS) imaging,
		- Local Barrier Height (LBH) imaging.
15	I-V Spectroscopy	0.3mV bias resolution for more than 65536 data points, with multi-point, line and grid mode.
16	I-V Spectroscopy Modes	*I/V, dI/dV (numerical)* & Normalized *dI/dV* plots, Export to ASCII option available.
17	**Spectroscopy with LIA**	Simultaneous *I/V* and *dI/dV* acquisition from STM and LIA output channels, for multiple sample locations, d^2I/dV^2 plots with locking on 2nd harmonic of the reference frequency.
18	I-Z Spectroscopy	Tunneling Current vs tip-sample distance plots, Conductance vs Distance plots (Normal and Semilog) with data export options.
19	I-t Spectroscopy	Tunneling Current or feedback signal output vs time plots, for different feeback control settings. Data logging and export options available.
20	Auxillary Channel Imaging	Signals from one other/auxillary ADC channel can be acquired simultaneously while taking scans in the regular CC/CH modes.

[1] Requires 5A Power Sockets (5 Points) that are properly grounded (voltage between neutral and Earth is $< 5V_{rms}$) both for the Electronics module(s) and its interfacing Computer.

[2] Lock-In Amplifier is an optional item, highly recommended.

S2 Scanner

	Sizes	Max. Area	Min. Area	X/Y Resolution
1	**XL Area**	$3.4\mu m \times 3.4\mu m$	$13.6nm \times 13.6nm$	$0.053nm$
2	**Small Area**	$348nm \times 348nm$	$0.13nm \times 0.13nm$	$5.3pm$
3	Z-resolution	Analog Mode : $\leq 10pm$		
		Digital : $1.7pm$ (in Fine Mode, using 16-bit DAC)		
4	Scan orientation	Horizontal and Vertical		
5	Max Z Range	± 400 to $\pm 550nm$ (Full-Stretch and Full-Retract)		
6	Sample approach[3]	Piezo-tube Walker with stick-slip motion, 10× magnified and illuminated tip-sample junction view.		
7	Sample size	Sample disc dia. 10mm.		
	XY Sample Positioner Stage (Optional)			
8	Range	3.5mm or $\pm 1.75mm$ sample-movement in both X and Y directions.		
9	Resolution	0.4mm (M2 feed-screw pitch)		
10	Control	Manual stage		
11	Dimensions	20mm × 18mm × 6mm		
12	Weight	25g		
13	Rigidity	Sub-angs vibration, stiffness to obtain atomic resolution		
14	Sample Mounts	Special XY sample plates (10 units)		

[3]Best suited for ambient conditions with relative-humidity (RH) $< 50\%$. Users to ensure requisite humidity-control arrangements at the installation-site where operating environment has RH higher than specified here.

S3 Vacuum Setup

1	Vacuum range	Ambient to 10^{-3} mbar
2	Vacuum Holding Time	Maintains 10^{-3} mbar pressure for 2-3 hours using Sorption Pump (SP)
3	Chamber Dimensions	25cm (dia) $\times$ $\sim$17cm (height)
4	Chamber Ports	8 ports i.e. 1" Butterfly (BF) Valve port (1), KF25 (4), KF16 (2), KF10 (1)
5	Spare Port(s)	2 out of the 8 ports i.e 1 each of the KF16 and KF25 ports
6	View Port(s)	1 (1" wide, directly above the tip-sample junction of the STM)
7	Vacuum Valves	Vacuum-Release Valve (1), 1" BF Valves (3)
8	Sorption Pump	For vibration-free pumping down to 1 x 10^{-3} mbar (used during scanning), no moving parts, re-chargeable, positive pressure safety vent, clean and non-contaminating operation
9	Sorption Pump Re-charge Setup	$\sim$200W heater jacket around the Sorption Pump, PT100 temperature sensor, PID-based temperature controller within $\pm 0.2^{\circ}C$ of the set temperature, (recommended baking temperature $120^{\circ}C$)
10	Rotary Pump (3^{rd} party supply)	For vacuum range 10^{-2} to 10^{-3} mbar
11	Liquid Nitrogen (not supplied)	8 to 10 liters per experiment
12	Vacuum Gauge	One Pirani guage-head with analog meter (in mbar)
13	Instrument Rack	Sturdy, no additional vibrations, fitted with Cryobucket Holder tray, $\sim$ 2ft. high
14	Cryobucket	A compact LN2 storage insulated vessel, of about 6 litres, in which the cryo-sorption pump is kept.
15	Exchange-Gas Port (Optional)	With on-off toggle valve, compatible with 1/8 inch pipe, on a spare port of the vacuum chamber. for non-corrosive gases only.

S4 Vibration Isolation (Inside Vacuum Chamber)

1	Cut-off frequency	<10 Hz. Vibration suppression ensures atomic resolution imaging with the Scanner.
2	Platform	Guide-holes & mating arrangement for scanner (limit-less mating cycles).
3	Isolation method	Passive.

S5 Software: SiM

	Features	Description
1	Image Display	Dual Imaging Window for Scan and Retrace Image Display (Image size: 256×256 to 7750×7750 pixels)
2	Oscilloscope	Multi-channel in-built software CRO for plotting signals from different ADC channels.
3	Movie Mode	Repetitive scan captured as frames of a movie, Movie processing, split into individual images and export to GIF format.
4	Sample Navigator	Graphical assistant for localized zooming w.r.t. a large area scan
5	3D	Colored 3D renderings, selection of color look-up tables
6	Data Export	Export to standard image file formats like jpg, ASCII, postscript format. Splits simultaneous channel data into individual image files.
7	Analysis Functions	Line (Single line profile) Extraction, localized Zooming, Roughness Display, Measure length and angles on the images, Spatial and Fourier Filtering, 2D-FFT with distance measurements.
8	Calibration	X/Y/Z-Calibration Utility.
9	Image Processing Tool	Slope and Z-drift Correction, Spatial and Fourier Low-Pass Filtering, Background Subtraction, Histogram Equalization, Zooming, Contrast, Contrast, Invert, Spike-noise Filter etc.
10	Batch Processing	Batch export to ACII, jpg. Export a batch or a sequence of scans into GIF animation.
11	Image Viewing	For quickly reviewing, basic processing, ranking and sorting *nano*REV™ images (`*.npic`).
12	Tip Locator Window	Displays current position of the tip over the sample.
13	Nano-Lithography	In-situ tip cleaning & restructuring utility by applying voltage pulses to the sample
14	Color Mode Selection	Customizable gray-scale and color modes for the image (both in 2D and 3D)
15	Installer flash-drive	With drivers and software packages for the entire set-up.

S6 Tool Kit

1	Pre-mounted Samples[4]	HOPG(1) and Optical Drive(1).
2	Tools	Tweezer sets (2), Sample keys (2), Silver ink (1), Tip wire cutter (1).
3	Spares	Blank sample disc (8 pcs).

[4]The demos with the pre-mounted samples would require a cleaning agent, preferably IPA (iso-propyl alcohol) 100ml, lint-free tissue paper (20 sheets), a 1/2 in. wide cello-tape roll and an aluminum-foil roll to be arranged by the user.

S7 Tip Kit

1	Platinum-Iridium tips	10 no.s with 0.25mm diameter, 8mm length.
2	Tungsten wire	0.25 mm diameter, 1m length.

S8 Manual

1	User Manual	Hard-copy (English) : 1 copy

S9 Sample Kit

1	Pre-mounted Samples	$\leq$ 10 no.s of HOPG (Highly Oriented Pyrolytic Graphite), Indium Tin Oxide (ITO) and Optical Drives.
2	Sample Key	1

S10 Computer (Third Party Supply)

1	System Configuration[5]	RAM $\geq$4GB, Min. Resolution 1024 $\times$ 768.
2	Computer Interface	With at least 3 spare USB 2.0 ports.
3	OS	Linux (runs on latest Ubuntu Long Term Support distribution).

S11 Optional: LIA Specifications (Basic)

1	Reference Generator	10Hz to 1MHz
2	Locking Harmonics	$f/2f$
3	Full Digital Control	Software control of all parameters of the reference generator, amplifier gains and low-pass filter (LPF) cut-off frequency.
4	Software Interface	Python and C++ SDK library for LIA control.
5	Main Power Supply input	220-240V AC/50 Hz
6	Computer Interface	USB 2.0 Port.

[5]Refer the quote for the detailed specs. of the computer being supplied. A regular computer table ($\sim 2ft \times \sim 4ft$) to be supplied by the user at the installation site.

S12 Optional: LIA (Lock-in Amplifier) Integration

1	Multi-channel Imaging	Simultaneous acquisition and display of LIA outputs as images or plots.
2	User Interface	Seamless control of all LIA parameters from STM software:
		- Frequency, amplitude and phase of the reference signal.
		- Amplifiers gain-settings, ac/dc coupling, LPF cut-offs.
3	I/O Signals Interfacing	Front panel accessibility of modulation input and LIA output signals on STM .
4	Digital Phase Control	Auto phase-offset (due to external network) compensation.
5	Harmonic Modes	Software selectable $f/2f$ harmonic locking modes with acquisition of d^2I/dV^2.
6	Data Integration	For multi-channel modes, all the related LIA parameters stored along with STM images and plots data.