kSA RateRat Deposition Rate Monitor

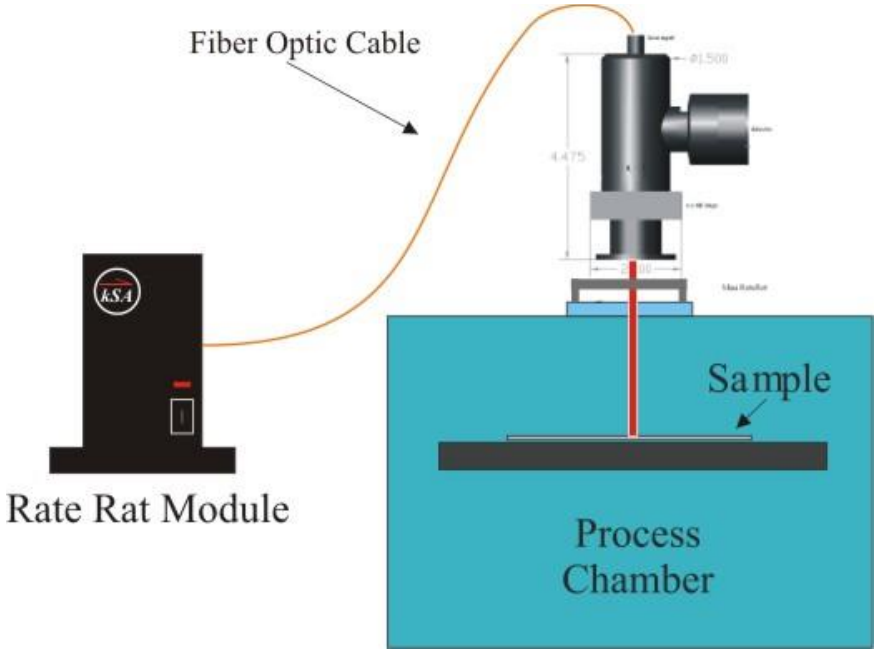
Product Specifications

The kSA RateRat Pro is a turnkey, real-time, in-situ optical reflectance probe designed for deposition monitoring of semi-absorbent thin films. The RateRat Pro measures deposition rate, layer thickness, and optical constants (n, k) in real-time using a diode laser and a high-speed photo detector. The RateRat Pro can be used in most thin-film deposition applications, provided that optical access is available. Using sophisticated "Virtual Interface" algorithms originally developed at Sandia National Laboratories, the kSA RateRat Pro detects and analyzes surface reflectance changes in real-time to determine deposition rate, layer thickness, and optical constants with as little as 350 Å of material. No advanced information related to the materials properties is required, just a simple calibration reference is used during initial system installation. All data acquired during a deposition run may be stored and loaded at another time for post-acquisition analysis. Typical thin-film deposition processes include MBE, CVD, MOCVD, sputtering, and evaporation.

STANDARD REAL-TIME ANALYSIS CAPABILITIES

kSA Technology	Technology Description
Layer Thickness	Measures individual total and individual layer thickness by tracking deposition rate and process time.
Deposition Rate	Waveform fitting the real-time intensity oscillations versus time to accurately determine the deposition rate without any advanced knowledge of the material properties.
Optical Constants (n,k)	Waveform fitting the real-time intensity oscillations versus time to accurately determine the optical constants (n,k) without any advanced knowledge of the material properties.

STANDARD SYSTEM HARDWARE LAYOUT



STANDARD HARDWARE

Laser Specifications:

Fiber-coupled laser diode with temperature stabilization

Laser Wavelength:	*658nm nominal (other wavelengths available upon request.)*
Laser Output Power:	*25 mW nominal max. measured directly at laser output; software controllable*
Beam Geometry:	*Gaussian output with integrated collimating lens cell 1.6mm $1/e^2$ beam diameter*
Operation Mode	*Constant current output*
Modulation:	*Software controlled, DC to 100 kHz*

Detector Specifications:

Amplified Silicon photo detector

Bandwidth:	*DC to 10MHz*
Gain:	*5 position with 10dB increments*
Input:	*Selection of lens cell receivers available*
Broadband Noise:	*0.3mV RMS (measured 0-10V full scale)*

Analog I/O Board Specifications:

User selectable DC or modulated detection up to 160 kHz.

Computer Interface	*PCI*
Input	*8-Channel Differential Input, 16-bit A/D, 160 kHz*
Output:	*2-Channel, 12-Bit Output, 100 kHz*
Digital I/O:	*24 channels available*

No user available generic I/O is supported with the standard system. Generic analog I/O support is available as an option as listed below.

- **Dynamic Signal Intensity Control (kSA Patented)**

During most films deposition, the surface and overall surface reflectivity will change due to material properties and/or surface morphology. k-Space has developed and patented a software-controlled method for dynamically adjusting the laser and/or detector integration times to maintain the highest S/N during these changes. This feature comes standard on all kSA RateRat related systems.

- **Computer System**

The kSA RateRat system can be supplied with a fully integrated computer, I/O board, and all software installed. Current computer specifications are as follows:

Computer Specifications:

Windows™ 10 Minimum of QuadCore Processor, 4GB DDR3 SDRAM, 500GB (minimum) SATA Hard Disk, 512MB DVI+HDMI Video Card, Gigabit Ethernet, USB2, USB3, DVD +/-RW, 22-inch Flat Panel Monitor, USB keyboard, USB optical mouse

OPTIONAL HARDWARE

- **Alternate Laser Wavelengths**

To accommodate alternate materials with higher reflectivity values at shorter wavelengths and to provide more rapid fitting with thinner films, optional 375nm,405nm, or 532nm laser and optics are available.

375nm, 405nm, or 532nm Diode Laser Module and Custom Optics

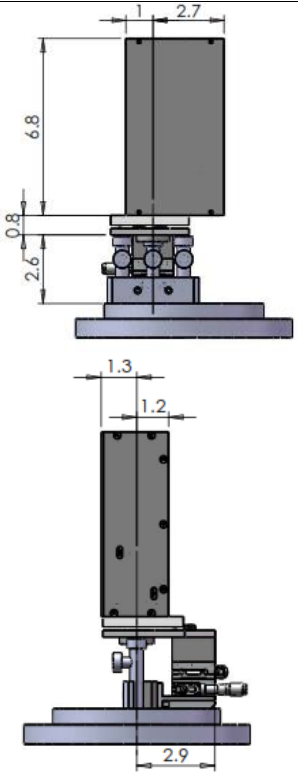
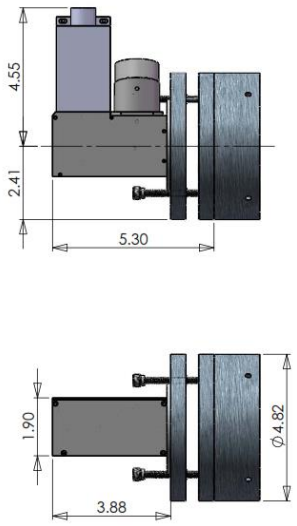
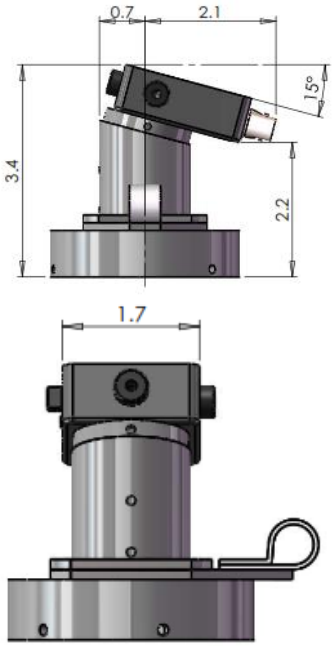
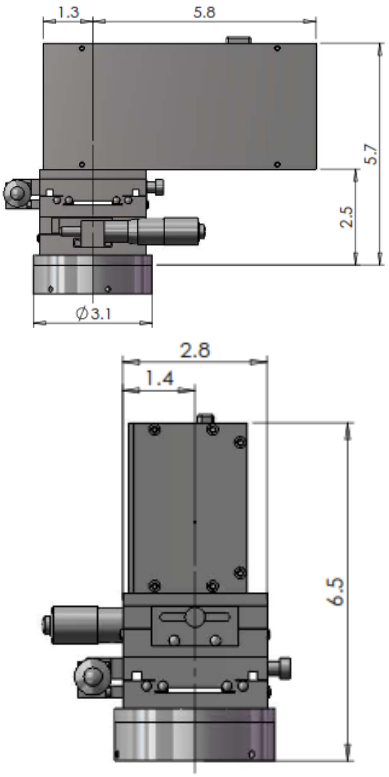
Specifications:

kSA RateRat Deposition Rate Monitor

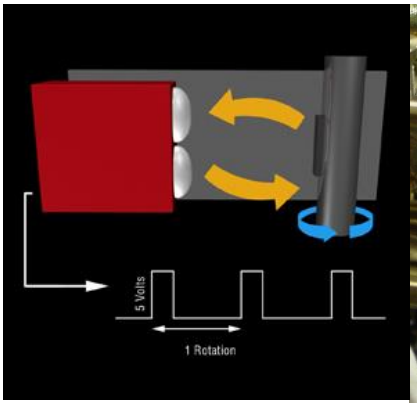
Fiber coupled, Peltier cooled laser diode package with integrated current controller and temperature controller.

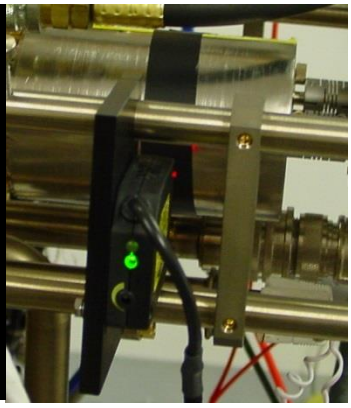
Laser Wavelength:	*405, 532, or 658nm nominal*
Laser Output Power:	*>25 mW, measured directly at laser output. Note: All high-power beams are confined within the MOS housing even when the cover is removed fo alignment. The cover is not interlocked. Direct access to the main beam is necessary during alignment. The total output power in the sample compartment is typically less than 50 microwatts.*
Beam Geometry:	*Circular Gaussian output with integrated long focal length lens cell*
Operation Mode:	*Constant current output*
Stability:	*≤ 0.2%*

Optical Enclosure and Chamber Mounting Options

Normal Incidence, Single Viewport		Specular, Dual Viewport Design	
MOCVD	MBE, Vacuum Chamber	MBE, Vacuum Chamber	
		Detector Housing	Laser Housing
			

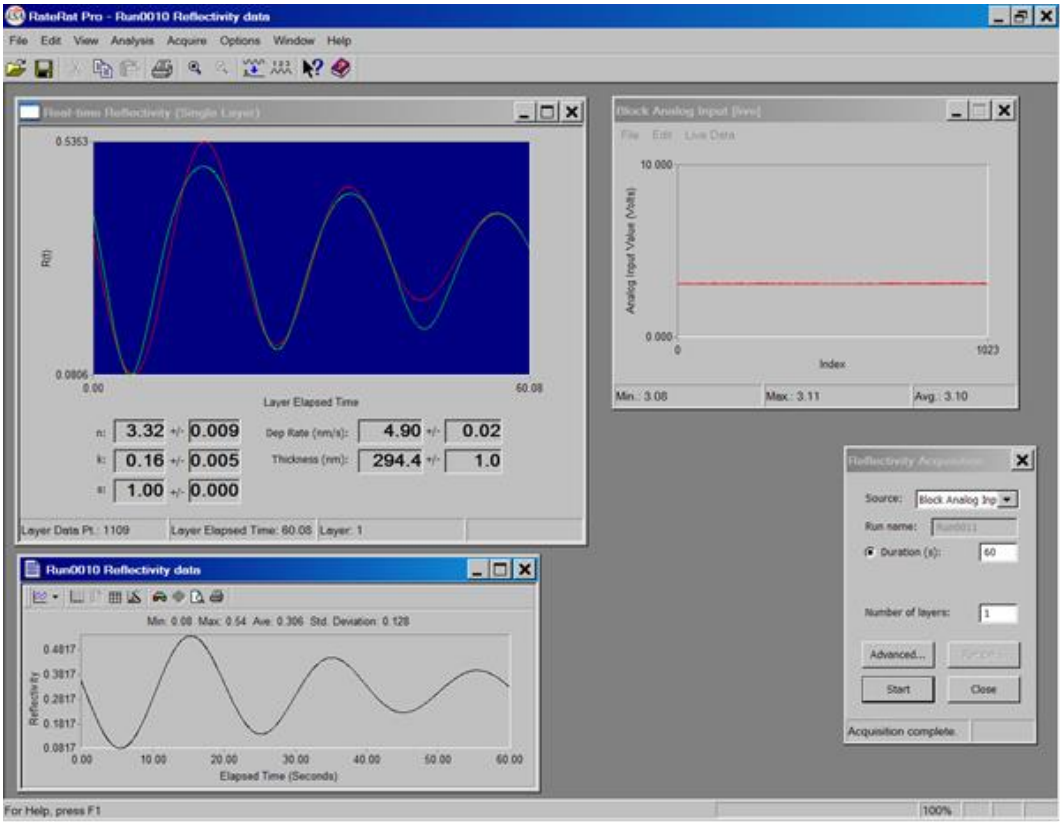
Rotational Triggering Module (RR-TRG)





The RTM (Rotational Triggering Module) product was developed by k-Space to meet the needs of scientists and engineers who desire an accurate trigger source coupled to a rotation stage during thin-film deposition. With the Rotational Triggering Module, the user can program precise trigger positions during rotation and use these triggers to initiate external events such as acquiring images or making measurements at specific rotation angles. By using a simple laser and photo detector assembly with close proximity mounting bracket, rotational speeds up to 2000 rpm can be properly tracked and utilized within any kSA product to define measurement positions. Custom mounting brackets are typically required for individual needs and can be manufactured at additional cost.

kSA RATERAT SOFTWARE DESCRIPTION

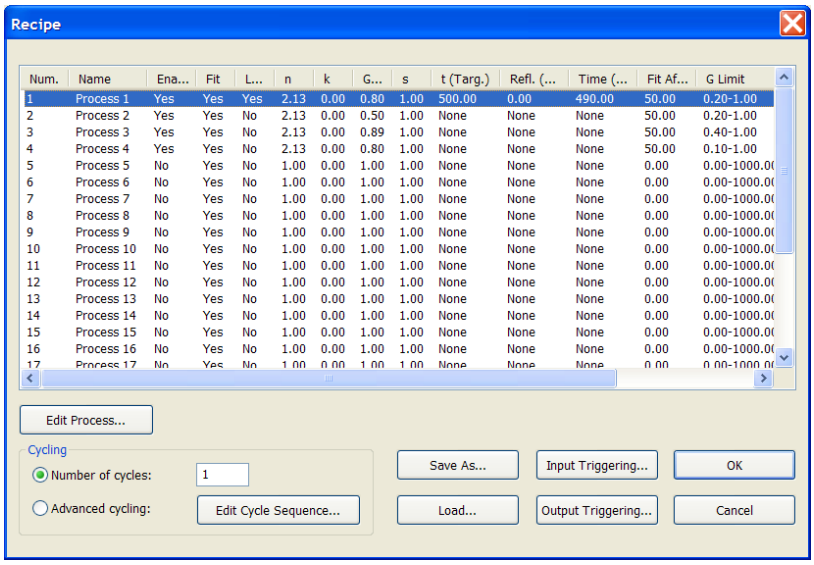


kSA RateRat Deposition Rate Monitor

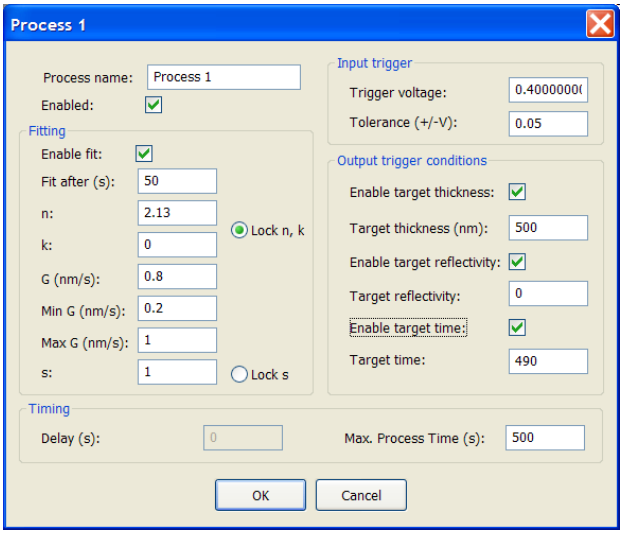
- Real-time update of current n, k, and deposition rate values and standard deviation of these values.
- Ability to output deposition rate, thickness, n, and k to analog output channels for input into process control system.
- External triggering can be used to time data acquisition with external events or substrate rotation if required.
- User-friendly Windows environment with extensive error checking and file handling. Data storage in ASCII and binary file formats facilitate alternative data analysis by user. Direct printing of graphics using currently loaded Windows printer drivers. Cut-and-paste directly to clipboard, or into other applications such as MS Word.

OPTIONAL SOFTWARE

- **kSA RateRat Recipe Control Software Module**
  - Ability to generate a thin-film deposition recipe, so multiple layers can be properly fit in real-time. Each layer in the recipe will have a user-estimated n, k, and G value. Each layer can be triggered via an external trigger signal or can be time-based.

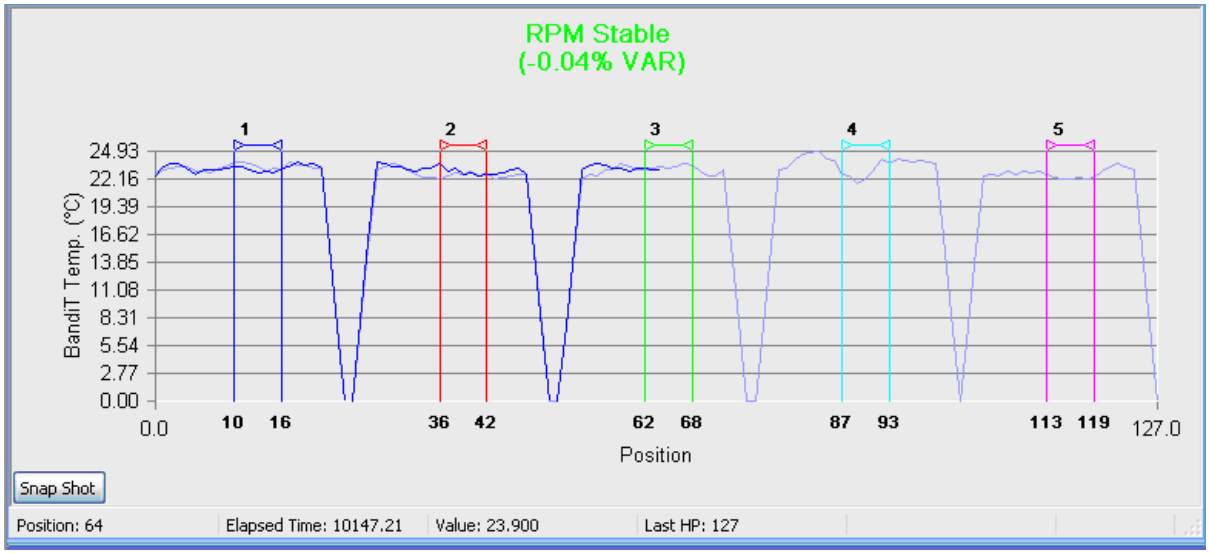


Recipe Table. The recipe table allows the user to see all the processes that have been programmed. Each process can be programmed to look for a target thickness, reflectivity, and a time limit. The system will output a TTL level signal to indicate that a process has been completed.



Process setup dialog.

- **Multiple Wafer/Point Tracking**



kSA RateRat uses signal intensity changes in the wafer and carrier to visually trace and define wafer positions during rotation. The user is then able to accurately place measurement "markers" at any position to enable real-time monitoring that location. Wide markers are available when averaging over a particular wafer or carrier area is desirable for process control. Up to 180 markers may be placed within or across multiple wafers.

Specifications are subject to change without notice. While due caution has been exercised in the production of this document, possible errors and omissions may occur.

July 24, 2020