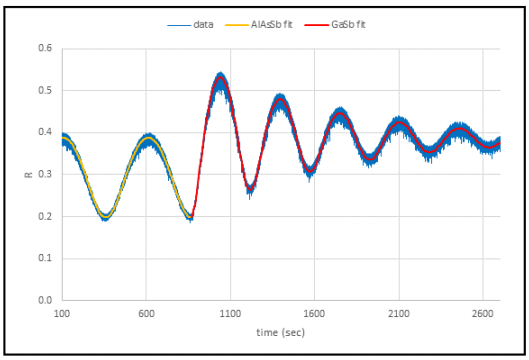
ICE for MBE

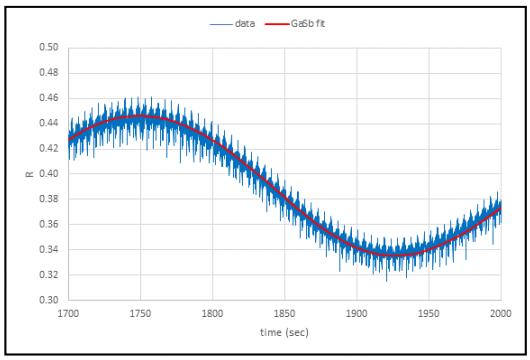
- Emissivity-Corrected Pyrometry
- Reflectivity
- Growth Rate
- Roughness

k-Space Associates, Inc. offers the kSA Integrated Control for Epitaxy (kSA ICE) instrument for MBE systems. The kSA ICE instrument is a modular *in situ* metrology system that has mainly been used in MOCVD systems to date. However, with optics customized to accommodate the longer optical path lengths and large substrate wobble often found in MBE systems, this tool is capable of performing continuous reflectivity measurements at a working distance of up to 1m. Although the substrate wobble introduces a considerable amount of variation in the reflectivity signals, kSA ICE is capable of producing excellent results due to its combination of high sensitivity, optimized collection optics, and a very robust reflectivity-fitting algorithm. Note that kSA ICE measurements can also be synchronized with the substrate rotation to remove the wobble-induced noise in the reflectivity measurement.

The figure on the upper right shows laser-based 974 nm reflectivity data from AlAsSb and GaSb films continuously acquired during rotation in a MBE tool. The scatter seen in the data results from the presence of substrate wobble in this MBE tool. Despite the significant wobble, the kSA ICE tool is able to fit the oscillations and provide a growth rate for both layers. The figure on the lower right shows a "close-up" view of the wobble induced data scatter. The kSA ICE algorithm achieves a growth rate fit after a layer thickness of ~ λ/4n. In the case of a GaSb layer (n= 4.25) measured with 974 nm light, we are able to acquire a fit after 60 nm, and after 75 nm of deposition the fit is fully converged. The ability for a reflectivity based tool to determine a given layer thickness depends on the material layer properties and the wavelength of the laser or LED used for measurement. Let k-Space help configure a kSA ICE tool for your MBE deposition application.



kSA ICE-R tool measured AlAsSb (n/k/G = 3.35/0.0/0.29 nm/s) and GaSb (n/k/G = 4.25/0.30/0.32 nm/s) films.



Although the wobble-induced scatter in the reflectivity is as large as ±0.02, kSA ICE is able to determine the layer thickness after ~ λ/4n of deposition.

ICE for MBE

Model	Description
ICE-ECPR-MBE	• Provides real-time monitoring of emissivity corrected pyrometry (ECP) temperature. • Provides real-time growth rate, film thickness, and optical constants using 960 nm reflectivity. • 2” optics and on-head photodetector mounting allows for greater ability to perform analytical fitting to reflectivity data with wobble-induced noise. • Offers triggered data acquisition once per rotation, if required. • Includes viewport mounting plate and x-y tilt alignment. • Includes CPU-based controller.
ICE-660LEDR-MBE/U	• Upgrade provides 660nm LED reflectivity with integrated growth rate monitor for real-time growth rate, film thickness, and optical constant (n, k) fitting.
ICE-532LEDR-MBE/U	• Upgrade provides 532nm LED reflectivity with integrated growth rate monitor for real-time growth rate, film thickness, and optical constant (n, k) fitting.
ICE-405LEDR-MBE/U	• Upgrade provides 405nm LED reflectivity with integrated growth rate monitor for real-time growth rate, film thickness, and optical constant (n, k) fitting.
ICE-XYMOUNT-MBE	• Upgraded X-Y stage with 1” of travel. Provides best alignment option for large path lengths and for small samples typical in MBE applications.

Reflectivity-based measurement tools require the use of an angled viewport to minimize back reflections and to provide the greatest dynamic range for your measurement. Laser upgrade options are available, as are reflectivity-only ICE MBE tools. Contact your k-Space representative for further details.

ICE-ECPR-MBE

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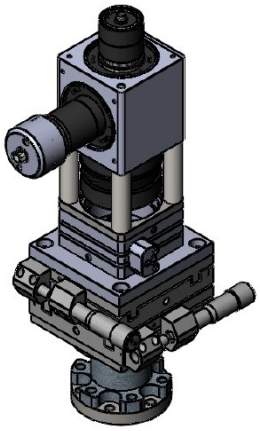
ICE-XYMOUNT-MBE



ICE-ECPR-MBE

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ICE-532LEDR-MBE/U

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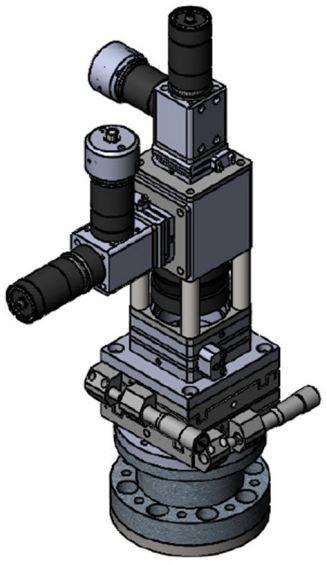
ICE-XYMOUNT-MBE



The drawings above show two standard ICE for MBE models. The first model (left) is used for emissivity correcting pyrometry and 940 nm reflectivity. The second (right) adds the ability to measure 532 nm reflectivity in addition to the standard 960 nm temperature and reflectivity measurement. Custom LED-based and laser-based configurations available upon request.

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.

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