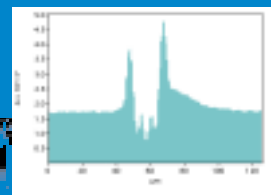
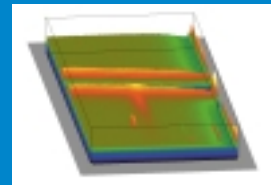


Digital Beam Control with high bit signal sampling and intelligent amplifier control to give simple automatic quantification of the EBIC signal.



*Smart*EBIC

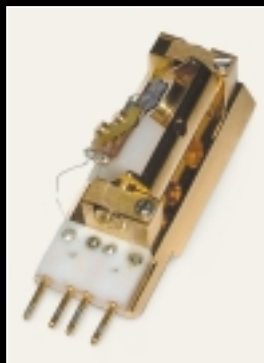


Precision Powering Productivity

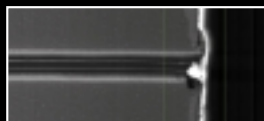
SmartEBIC

SmartEBIC is a new product which brings power, flexibility and ease of use to the technique of Electron Beam Induced Current (EBIC). SmartEBIC is a unique product based on Gatan's DigitalMicrograph™ software platform, combining Digital Beam Control with high bit signal sampling and intelligent amplifier control to give simple automatic quantification of the EBIC signal. The product is suitable for Scanning Electron Microscopes (SEMs) and also STEMs.

EBIC is a well established technique used to characterise the electrical properties of semiconductor materials and devices. With an internal electrical field present (e.g. a p-n junction), an electrically contacted specimen can detect the flow of electrons and holes which are created by the electron beam. Furthermore, any variation in the generation, drift or recombination of the charge close to the generation volume can be measured as contrast. In this way EBIC reveals the local, sub-surface electronic structure of the semiconductor specimen. As the EBIC signal is very strongly influenced by electron hole pair recombination, the technique is a powerful way of characterising defects and their detrimental effect in materials and devices. For standard EBIC experiments, no bias is required.



Tilting sample holder.



Failure analysis on damaged laser diode.

2 Low noise signal cabling and battery powered amplifier.

SmartEBIC is designed to acquire DC EBIC signals with minimum noise. This is achieved with careful design of signal cabling and vacuum feed-throughs and a high performance, rechargeable amplifier.

3 Easy to control amplifier interface with intuitive auto-routines.

SmartEBIC includes sophisticated autocalibration, auto gain and auto offset routines to ensure simple operation. For quantitative measurements pixel dwell times are automatically suggested to be compatible with the measurement type and amplifier gain settings. Beam current measurement is also implemented as a simple wizard type routine.

4 DigiScan beam control and signal sampling.

SmartEBIC employs DigiScan, Gatan's flexible Digital Beam Control unit, and includes two analogue inputs as standard, which can operate simultaneously. The user has a choice of standard imaging, or requesting a quantified scan from an area, sub-region or linescan. Signals are sampled with high bit precision, and with flexible choice of pixel number, width, height, and dwell time. This variable aspect ratio is especially useful for EBIC measurements on some devices. Other useful functionality includes scan rotate, position beam, waveform monitor, integrate persistence and line sync.

SmartEBIC

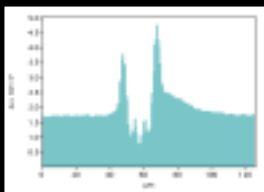
For SmartEBIC to produce high quality, quantitative results in a simple manner, there are five key steps.

1 Specimen contacting, and quantification of diode characteristics.

SmartEBIC provides a special dovetail EBIC specimen holder which is suitable for bench-top contacting and airlock loading*. This holder provides a tiltable mount to allow contacted specimens to be examined in plan view and cross section mode. The holder also comprises electrical probes which can be positioned and lowered, and an integral Faraday cup for beam current measurement. SmartEBIC software provides the unique ability to perform I-V tracing. This is very useful for quantifying the probe contact and the device characteristics.



Plan view Schottky contact.

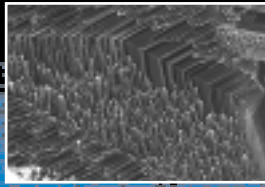


Post acquisition line-profiling.

5 DigitalMicrograph™ image processing, and environment for presenting and archiving results.

DigitalMicrograph™ is now the industry standard software environment in many fields of SEM and TEM. It provides unique flexibility in terms of post acquisition analysis, display and presentation. In addition to live linescans, post acquisition line profiles can be extracted from images for advanced analysis. With SmartEBIC a simple routine of least squares analysis of exponential curves from quantified profiles or linescans can be used to extract values of the minority carrier diffusion length. Also many different mathematical functions can be applied to images and data sets.

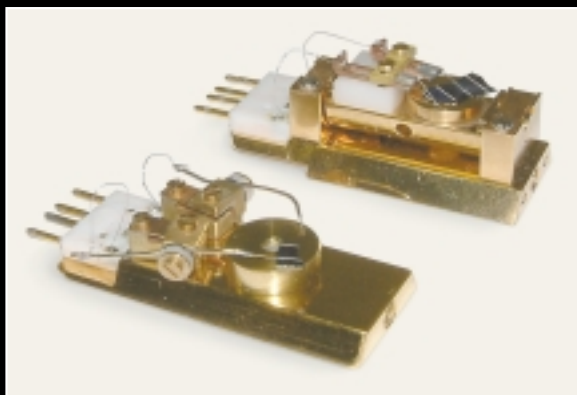
SmartEBIC



Etched Si photovoltaics.

Components

- DigiScan unit including 2 x analogue inputs for sampling SEM and EBIC signal. Up to 2 more inputs can be optionally installed for simultaneous acquisition of other signals. DigiScan employs Firewire communication technology which includes a PCI Firewire computer card.
- Low noise battery powered (rechargeable) current amplifier with RS232 interface and cable.
- Current specification computer with flat screen monitor.
- DigitalMicrograph™ and SmartEBIC software for automatic control of amplifier, electron beam and signal sampling.
- Tilting Sample Holder (TSH) for bench top contacting of simple specimens. Contains 2 adjustable tungsten probes, connecting pins, Faraday cup, electrically isolated mount. TSH is designed for bench top tilting so that specimens can be examined in plan view and cross section.
- Internal connecting plug and socket.
- Specimen holder exchange tool for use at air.
- 4 BNC type, low noise and vacuum compatible feed-throughs. One feed through is dedicated to beam current measurements.
- Internal low noise signal cabling.
- SEM stage adaptor to take sample holder. (not supplied or required if product is intended for integration with Gatan cold stages.)*
- External EBIC and Beam Current signal cabling.
- External test box including low noise current source, and photodiode.
- Support documentation.



Advanced and tilting sample holder.

Optional

- Advanced Sample Holder (ASH) can be supplied as an alternative or additionally. ASH is designed for bench top spring loaded lowering of probes but no tilting.
- For EBIC in the Scanning TEM, a specimen holder with electrical contacts is required. Please discuss with Gatan.
- Other specimen holders are available which involve manual ex-situ wiring for electrical connections. Larger area specimen holders by special quotation.
- In-situ, high precision specimen contacting using a probe or probes. Control is typically by remote joystick(s) independent of SmartEBIC software.

** TSH and ASH specimen holders are suitable for airlock loading using Gatan's C1010 product. Other microscope manufacturers airlocks may not be compatible. TSH and ASH are provided with spare tungsten probes.*



Software Features.

DigiScan

Acquisition of one or two images (simultaneously) with user specified choice of height and width (pixels), dwell time with refresh and record modes. Also control of persistence, scan rotate, linesync with frequency, signal monitor and spot beam modes. Image magnification calibration (for scale marker bar and quantification), using user input microscope magnification. Choice of autoscaling routines, histogram tool, user specified or defined intensity look-up tables. Colour mix for auto colouring and overlaying of images with drift correction.

SmartEBIC plug-ins.

Simple, user friendly control of bipolar amplifier including reset function, polarity switch, amplifier gain (toggle with sensitivity), offset current and bias. Gain and offset can be controlled in step and Vernier scales.

One-step autocalibration routine with optional choice of higher accuracy zero offset measurements.

One step, individual auto gain and auto offset, and combined autoscale routine to optimise amplifier settings to user specified region of interest (ROI).

Continued overleaf...

SmartEBIC

Software Features *continued*

I-V tracing with choice of step size between 5V within 5mA source current limitation. Also, I-V tracing can be performed whilst scanning selected ROI.

Beam current measurement routine with intelligent amplifier autoscaling.

Simple *SmartEBIC* acquire routine from user specified ROI to obtain quantitative maps or linescans. Automatic suggestion of pixel dwell times suitable for amplifier gain, pixel density and line synchronization option, with live update of acquisition times. Choice of reporting results as EBIC or ratio between EBIC and measured beam current.

The acquire routine can also be used to obtain quantitative voltage maps. User is prompted to bypass the current amplifier so that system can be used to quantify other signals.

Convert to abs-log Scale function can be applied to all data.

Automatic routine to fit cross sectional linescans or line profiles from user specified ROI to 1-D diffusion equation.

Choice of measuring DigiScan signal as quantified Voltage rather than Current.

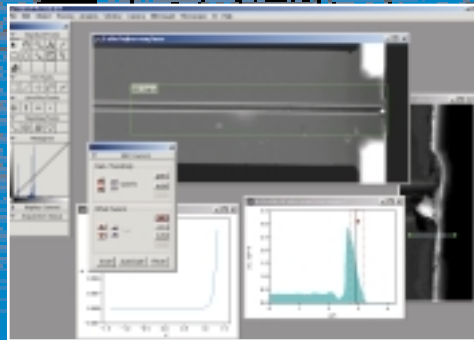
Other DigitalMicrograph™ features.

Simple math functions can also be applied to all data sets.

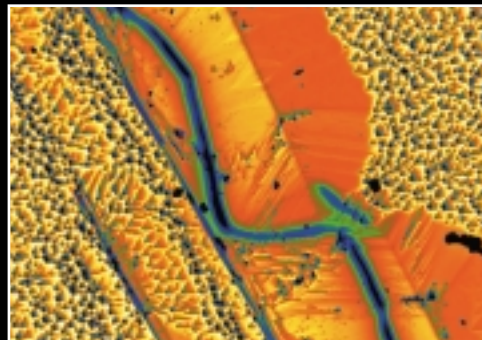
Post acquisition line profiling tool with choice of width integration.

Choice of display options for 2-D results; raster, spreadsheet, surface plot. Versatile overlay and manipulate features for 1-D results.

Professional creation of reports employing standard windows protocols. Results within reports can be processed within DigitalMicrograph™ and exported in a variety of formats.



Example DigitalMicrograph™ user interface.



EBIC image using thermal representation of defect in Si photovoltaic.

Notes.

SmartEBIC produces EBIC images for DigiScan only, and is not designed for quantitative use with an SEM AUX input.

Please discuss with GatanUK or your local contact in the following cases.

For customers with existing DigiScan, DigitalMicrograph™, EBIC or MonoCL3 products wanting to upgrade to *SmartEBIC*.

For customer wishing to contact specimen in-situ.

For customers requiring larger area sample holders, airlock loading, or for TEM EBIC.

For customer wishing to perform AC EBIC.

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