Electrical Analysis for TEM

In-situ imaging of electrical activity at the nanoscale

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Enable direct correlation of electrical activity with high resolution data
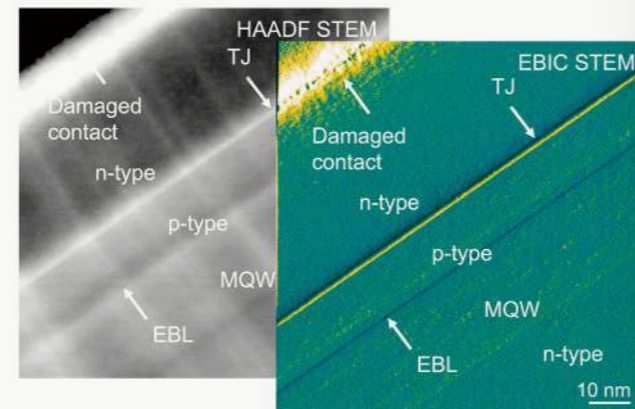
Add the Electron Beam Induced Current (EBIC) technique to TEM

- Inelastic loss induces electron-hole pairs in the lamella
- Internal electric fields separate electrons and holes
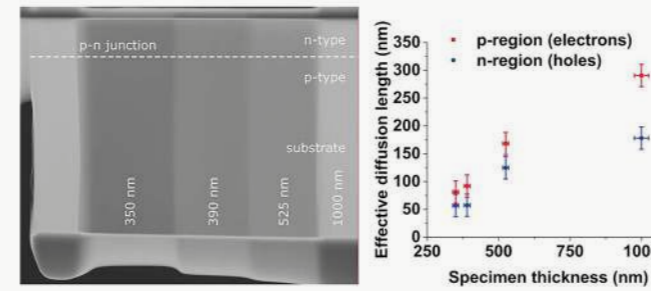- Current is measured to acquire EBIC STEM images
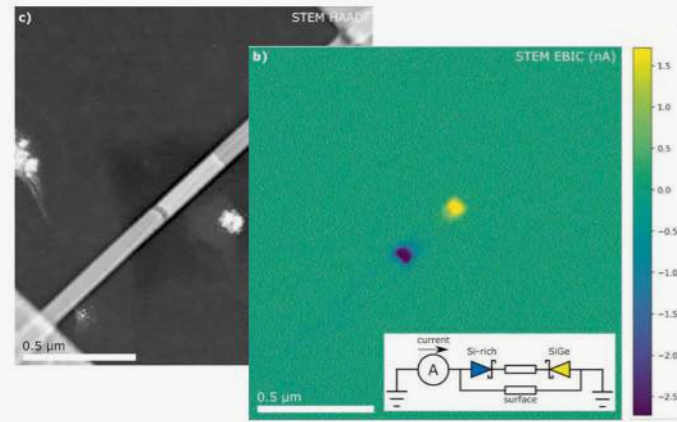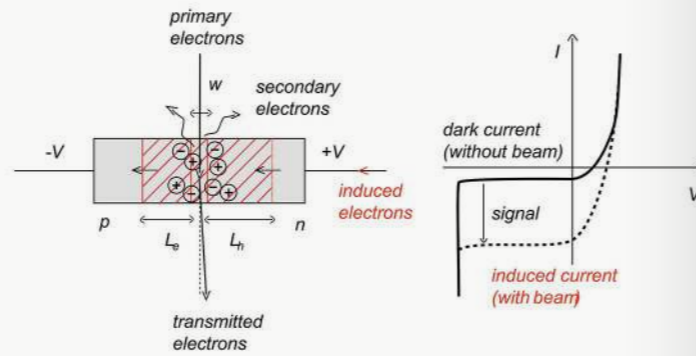
Reveal internal electric fields

- Map junctions and contacts in devices
- Validate doping profiles against design
- Correlate with device model and parameters

Determine fundamental parameters

- Depletion width at junctions
- Diffusion length of minority carriers
- Recombination strength of dislocations

EA for TEM

Discover electrical activity of each layer

- Localize sites with increased recombination activity
- Distinguish defects with/without electrical activity
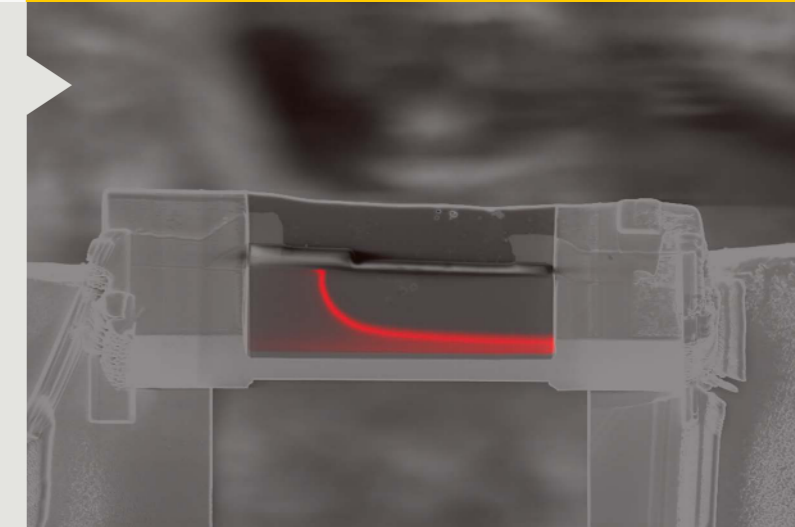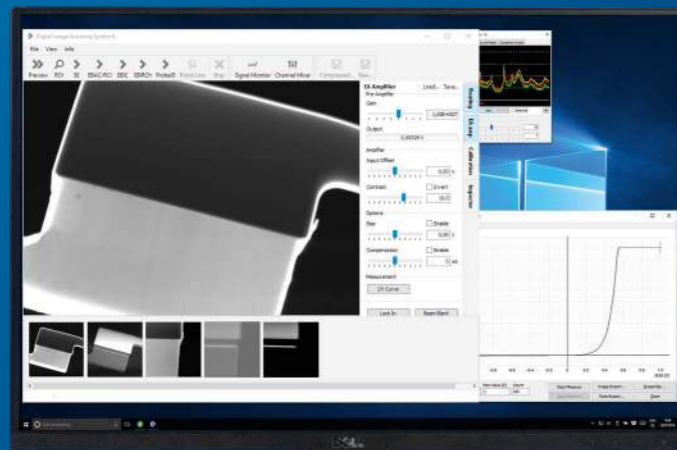- Continue with high-resolution techniques

Screen FIB-SEM samples

- Apply standard FIB workflows for in-situ biasing
- Use wide field-of-view of EA in SEM to select target
- Verify lamellas in SEM for preparation damage

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Turn-key solution for in-situ TEM

Electronics are fully integrated and software controlled

- Fast amplification optimized for imaging
- Wide gain range to fit all techniques
- Miniaturized on-holder electronics
- Automated signal routing
- Reference sample for training*

* optional

EA electronics for in-situ biasing holders

- First stage analog amplification for minimum noise
- Wide gain range for all EA techniques and samples
- Built-in voltage bias and current compensation
- Automated signal routing to avoid electric discharge
- Switchable low passes for signal filtering
- Automated zero adjustment

TEM Scan Controller (DISS6)

- Integrated scan generator and image acquisition
- Large pixel resolution and high scanning speed
- Second stage digital amplification for EA
- Simultaneous BF, HAADF and EA inputs

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Integrated and easy-to-use quantitative software
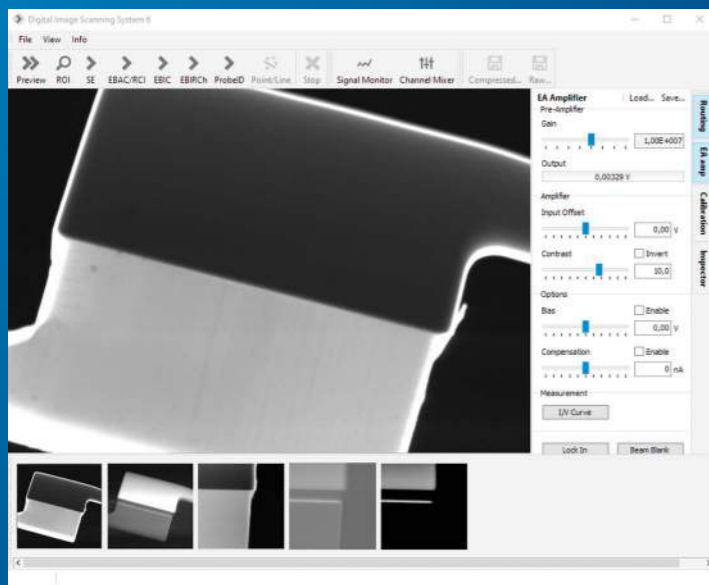
### DISS6 - control and acquisition software

- EA amplifier control
- EA, HAADF and BF image acquisition
- Automatic quantification to µA...fA
- Current-voltage sweep tool
- Live image colour mix tool
- Standard file formats

DIPS6 - processing software

- Full image and metadata viewer
- Automatic quantification to µA...fA
- Gradient-based pseudocolours
- Colour mix of signals for visualization
- Export of quantitative pixel values
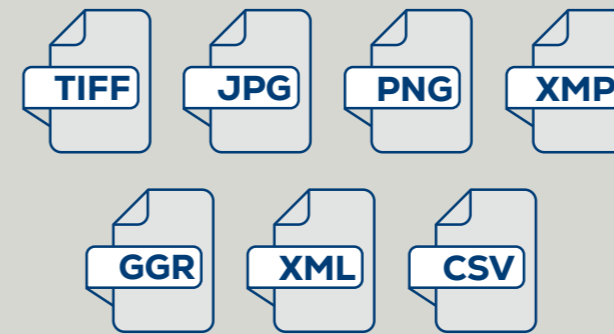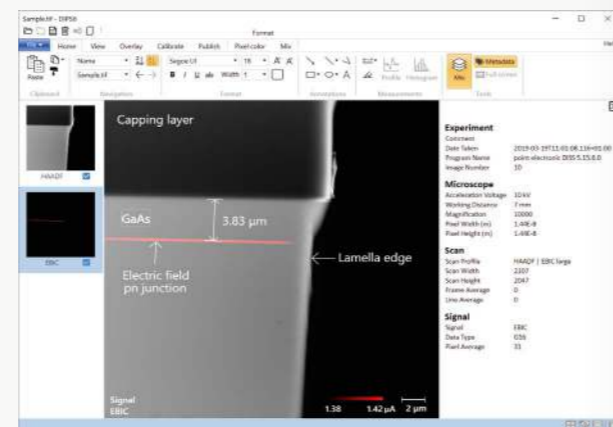
Standard file formats

- TIF un-compressed grayscale data
- JPEG compressed grayscale data
- PNG colour images
- XMP metadata
- GGR colour gradients
- XML formulas
- CSV pixel values

EA for TEM

Automatic quantification of pixel values

- Analog EA signals are factory calibrated
- DISS6 and DIPS6 softwares show quantified values
- Metadata includes calibration parameters
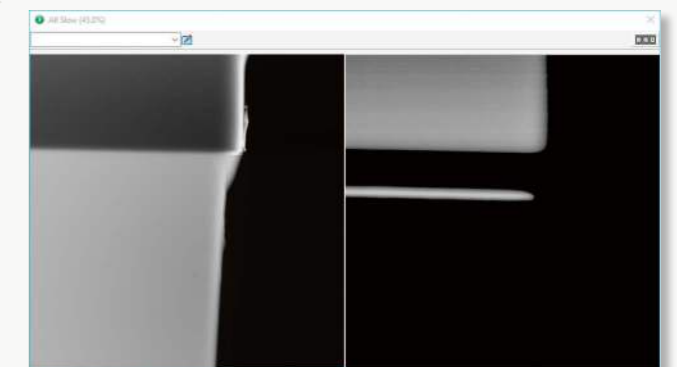
Integrated current-voltage sweep tool

- Configurable range, points and measure time
- Verify electrical connections to device
- Inspect for electron beam damage

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EA electronics for in-situ biasing holders

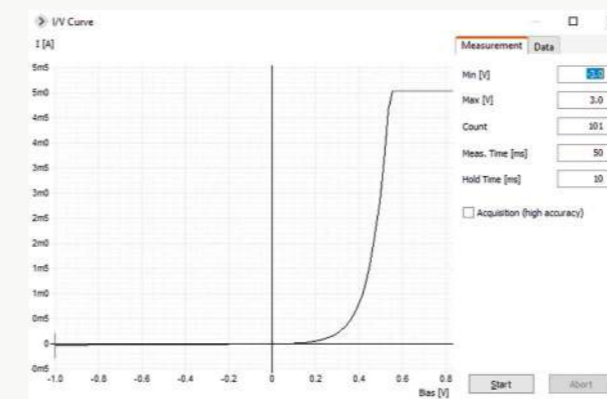|	
Input channels	4x to in-situ biasing holder, or
	6x to in-situ biasing holder
Routing	EA high (pre-amplifier)
	EA low (ground or bias voltage)
	External
Pre-amplifier	$10^4 \dots 10^9$ V/A variable gain
	approx. 100 kHz bandwidth at 10^7 V/A
Internal sources	-5 … 5 V, 16-bit bias voltage
	-1 … 1 µA, 16-bit compensation current
	10 µA, 30 µA and 100 µA bias current limits

TEM Scan Controller (DISS6)

Signal inputs	1x calibrated EA
	4x STEM
Digitization	20-bit EA, saved to 16-bit, 1 Msps
	12-bit STEM, saved to 16-bit, 100 Msps
Scan generator	X and Y scan outputs (calibrated)
	Beam blank output (optional)
	64k × 64k pixels maximum resolution
	0.5 GPixels maximum frame size (software limit)
	1 µs minimum pixel dwell time (EA input limit)
Synchronization	Pixel, Line and Frame trigger outputs
	10ns…. 100ms trigger lenghts
	Pixel, Line and Frame trigger inputs

PC/Laptop, Display

PC/Laptop	Intel Core i3 minimum
	2x USB 2.0 minimum
Display	1,280 x 1,024 resolution minimum
Operating systems	Windows 11 … 7
	Network recommended for remote support

DISS6 software

EA amplifier control	Gain, Contrast, Brightness, Bias, Compensation, Inv.
	Save/load amplifier profile
TEM Scan Control (DISS6)	Configurable scan profiles
	Signals, pixel resolution, speed, averaging, sync
	Manual/automatic image range
Inspector tool	Automatic quantification of pixel values
	Editable formula files
Current voltage (IV) tool	Voltage range, steps, time
	Live plot with data and graph export
Image mixing tool	Manual colour assignment
	Live mix with image export
Save file formats	uncompressed 8-bit or 16-bit multi-page TIF
	compressed JPEG
	XMP metadata embedded into TIF and JPEG
Operating systems	Windows 11 … 7

DIPS6 software

Input file formats	Uncompressed 8-bit or 16-bit multi-page TIF
	Compressed JPEG
	XMP metadata embedded into TIF and JPEG
Export file formats	PNG images
	CSV data with pixel values
View modes	Single page image and metadata
	Multiple pages/file
	Layers/image mix view
Quantification	Automatic, using XMP values and formulas
	Manual, using XML formulas
Pseudo-colour	GGR gradient based colour mapping
	Automatic and manual control of range
Annotations	Lables, arrows, lines, rectangles, circles
Measurements	Distances, angles
	Line profile
	Histogram
Operating systems	Windows 11 … 7

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Parts and Cables

EA biasing holder electronics	Standard	1x
TEM scan controller (DISS6) with LIA input	Standard	1x
EA biasing holder cable	Standard	1x
EA ground strap	Standard	1x
TEM signal cable	Standard	1x
TEM external scan interface cable	Standard	1x
USB cable	Standard	1x
USB memory stick with software	Standard	1x
EA reference sample	Optional	1x
PC, keyboard, mouse	Optional	1x
Display	Optional	1x

Software packages

Drivers	PEUSB
Libraries	DISS6Control
Software	DISS6 software
	DIPS6 software
	EMGateway server

Weight & Dimensions

EA biasing holder electronics	66 mm length typ.
	60 mm diameter
EA DISS6 imaging	64 x 8.7 x 29.5 cm
	3.4 kg
Shipping	typ. 64 x 32 x 56 cm
	typ. 7.5 kg

Site requirements

Power	1x mains 110/220 VAC single phase 50-60 Hz
	on the same earth as the microscope
Microscope	1x biasing holder (see compatible models)
	1x external scan interface
	1x video connection (HAADF prefered)
	1x microscope ground
Space	EA electronics must be mounted on the TEM in-situ biasing holder
	TEM scan controller may be placed in a TEM electronics rack

EA for TEM
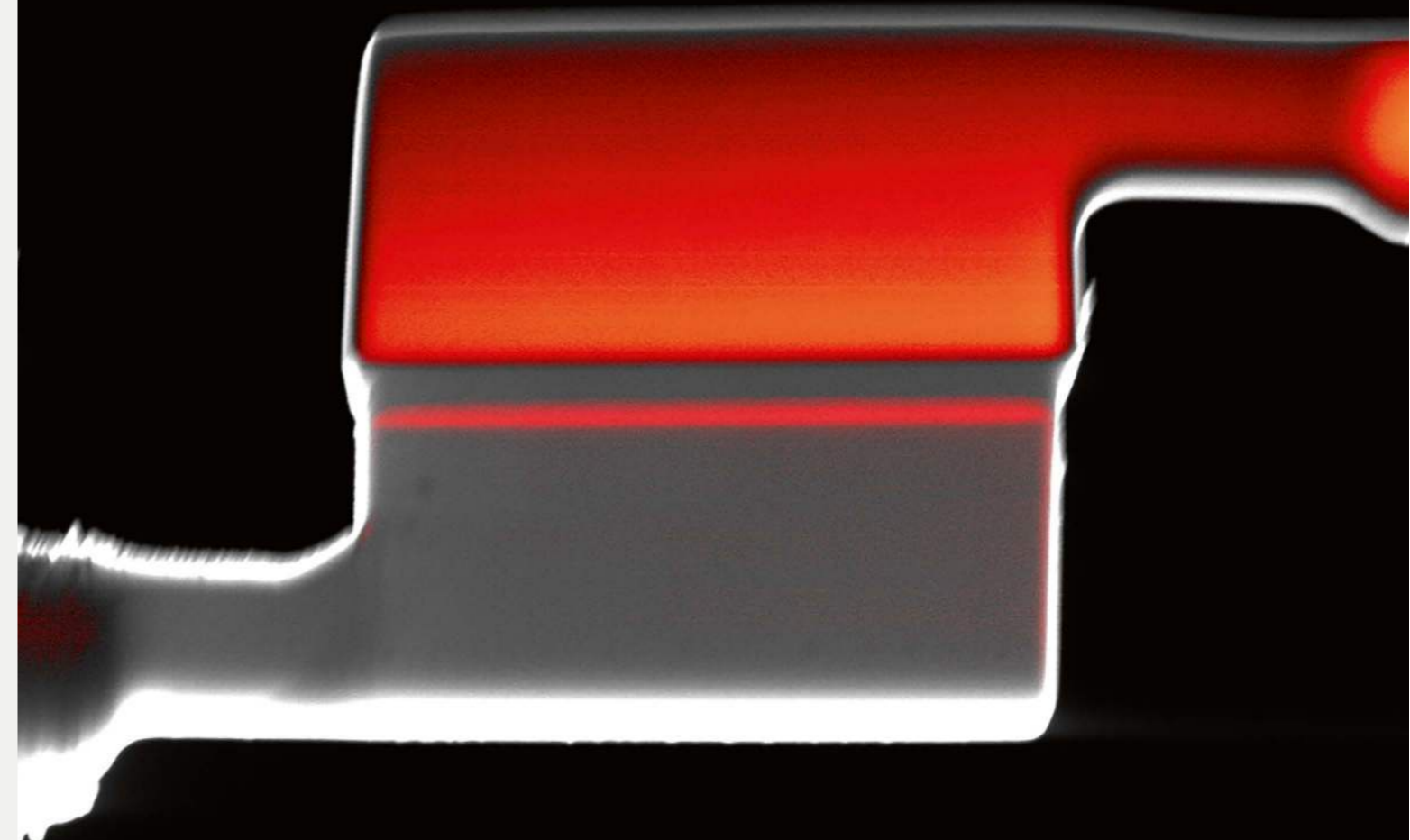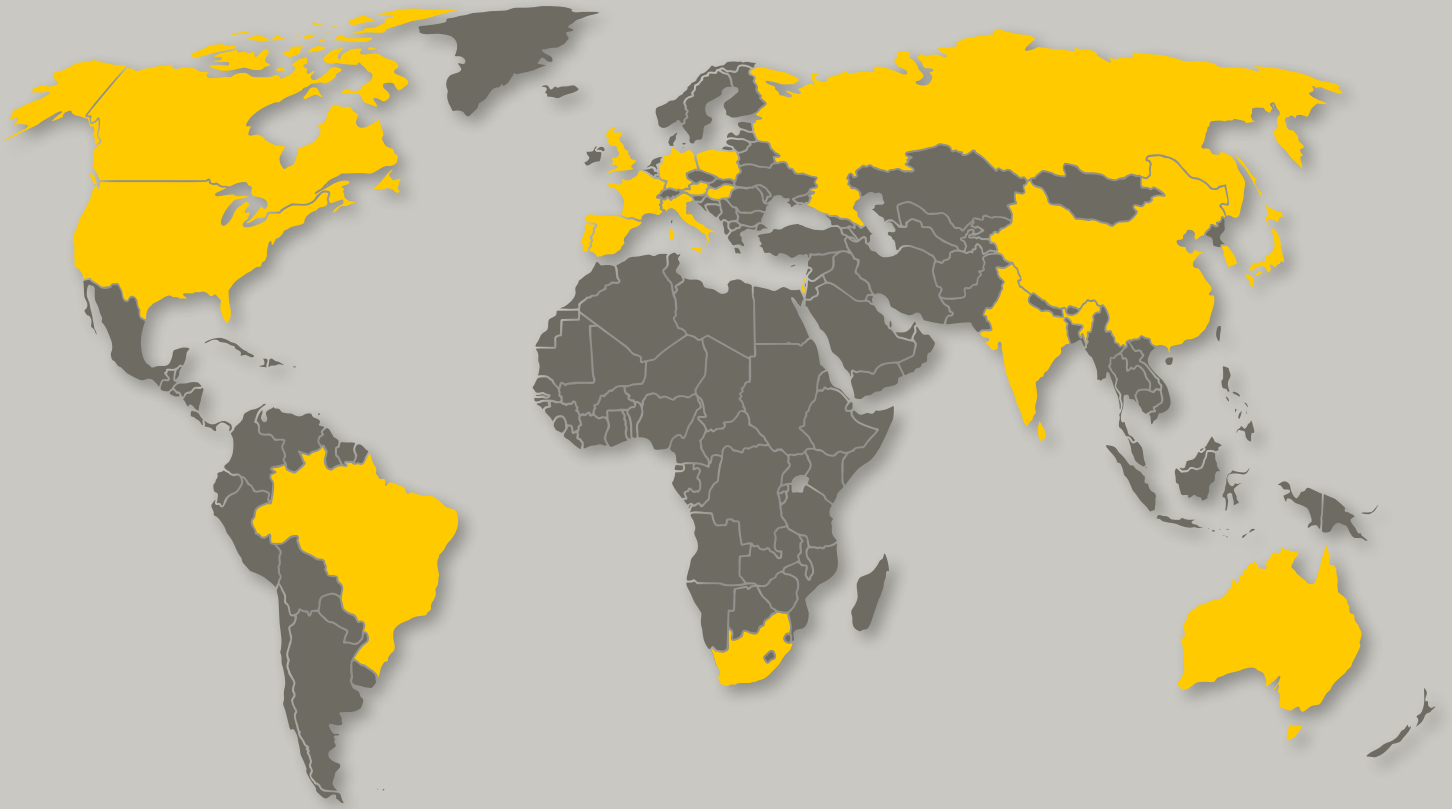
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