

# Enhanced EMMA

Multi-Materials Analyser  
X-Ray Powder Diffractometer



**GBC**

SCIENTIFIC EQUIPMENT



ISO9001  
Quality  
Accreditation



GBC has always placed a strong emphasis on quality in all aspects of our operation, from design and manufacture to the provision of service and support to our customers, and we are fully committed to continuous evaluation and improvement in all areas.

The GBC Quality Management System has been accredited to the ISO 9001 quality standard by Lloyd's Register Quality Assurance Limited. This certification is your assurance that the procedures and processes used to produce the goods and services which GBC provides comply with the relevant International Standard, and demonstrates commitment to meeting the needs and expectations of our customers.

For 30 years GBC has been at the forefront of scientific technological development, manufacturing and marketing a wide range of award winning, quality scientific instruments.

Sensitive Technology  
for a Sensitive World

### GBC Scientific Equipment

will advance people's knowledge and  
their capacity to enhance the quality of life  
for all humankind.



### GBC's product lines...



AAS



HPLC



ICP-OES



ICP-oTOFMS



Rheometry

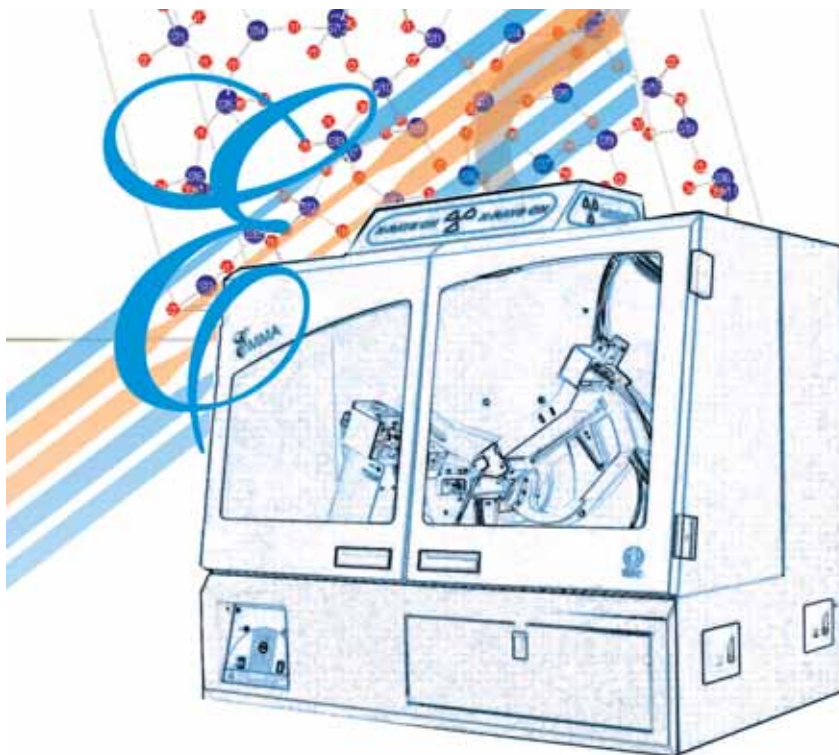


UV-Vis



XRD

# The Enhanced Multi-Materials Analyzer with Maxi-Capabilities



Available in Theta-2Theta geometry or in Theta-Theta geometry for high temperature and environmental stages.

Keeps a constant irradiated area with motor-driven auto slits.

Communicates directly via Ethernet TCP/IP over a managed network or direct connection to PC. EMMA supports either fixed IP address or DHCP.

Supports a wide variety of sample sizes.

The multi-disciplinary capabilities and affordability of EMMA makes it the perfect choice for many industries. The compactness and light weight of EMMA makes it easily transported.

**For Materials Research** - its range of optics, stages and detectors, with their interchangeability. The wealth of software available through the "Open Software" policy make it an obsolescence proof investment.

**For Mining and Geology** - its portability and integration with the latest ICDD® databases and compatibility with quantitative analysis with the renowned SIROQUANT® package, make it a productive tool.

**For Process Control** - its simplicity of operation and stability means reproducible data. Its autoloader and sensitivity for minor phases extends its analytical range. For example, it can be used in Cement Clinker analysis, Pharmaceutical Research and Industrial Minerals.

**For Metallurgy** - its slim-profile Eulerian Cradle means Chi-offset Residual Stress measurements can be made at extreme back reflection angles. This feature together with the flexibility of Pole Figure data collection in many different formats and the "Open Software" availability of advanced Texture Analysis capability means it is an ideal research tool.

**For Thin Film Analysis** - its choice of optics, precision-adjustable sample holder and detector configuration, means it can be used for Glancing Incidence scans.

EMMA is also suitable for:  
**Pigments and Dyes** - identification  
**Forensics** - Crime scene evidence  
**Archaeology** - analysis and correlation of artifacts  
**Conservation** - authentication of works of art  
**Environment** - Contaminant dispersal and mitigation work  
**Soil Science** - Clay Mineralogy.  
**Semiconductors** - Alloys, Thin Films, packaging  
**Nano-materials** - particulate size, alloying.



## Enhanced Powder Diffractometer

# Components for Best Results



## Slit Optics (Standard)

The basic divergence optic is the slit optic. It includes divergence slits for 1°, 2° and 3° divergence, and the primary beam Soller slit. The very narrow receiving slits can be fitted for special applications.

The E<sub>MM</sub>A in basic configuration offers a complete package, and will perform superbly for routine powder scanning. For more advanced or specialised applications, there is a wide range of options and accessories.



## Planar X-ray Waveguide Resonator

A unique optic for large d-spacings and less ordered materials. It produces a thin beam from a narrow gap between optically flat plates, resulting in excellent efficiency for less ordered materials.

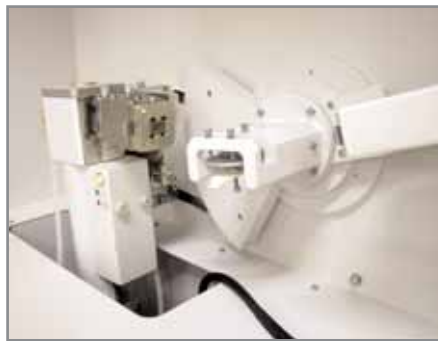
## Choice of Optics

All optics are pre-aligned and interchangeable on the Dovetail slide without realignment.



## Polycapillary Optics

The optional monolithic optic "X-ray Lens" from XOS®. This monolithic optic is ideal for off-axis specimen alignment applications such as Texture and Residual Stress. The 6 mm dia. beam is supplied as standard. The large (10 mm dia. beam) as shown is available as an option.



## Mirror Optics

For surface studies, a parallel beam Ni/C parabolic mirror with angle offset for the tube shield is available. All installed optics are pre-calibrated in the software.



# Geometries

# Choice of Detectors and Optics



## Xe Proportional Detector Graphite Monochromator

Available in Cu or Co monochromators. (The Cu monochromator is standard with the basic E<sub>MM</sub>A package. Both monochromators utilise a special Xe proportional detector tube and low-noise preamp (linear to >90000 cps). A receiving slit, secondary Soller slit and scatter slit all work together to improve the resolution and shape of the measured peaks.



## The Solid State Detector

This replaces the Xe detector and does not need a monochromator as it separates CuK $\alpha$  and CuK $\beta$

by energy dispersion. It is a Peltier-cooled Si PIN Diode with active area 2 mm x 12 mm, making it ideal for powder diffraction. Choice of any other wavelength is simply done by setting a new ROI (region of interest) via software. Count rates are typically 3x to 4x higher than for the Xe detector with graphite monochromator.



## X-ray Fluorescence Detector

Peltier-cooled Si PIN Diode detector with miniaturised pulse processing electronics and multi-channel analyser with USB interface. Software for qualitative identification with an element-line database and calibration for quantitative analysis is included.

Two mounting options are included:

The Over-Stage mounting as shown above can be used in Total Reflectance mode with an appropriate collimator (very low angles minimise background).

The Polarised-Optics device mounting, which mounts on to the Tube-shield dovetail slide has an orthogonal 45° scattering geometry which eliminates primary beam and uses a secondary target to minimise background.



## Parallel Beam or Thin Film Detector

This includes a long soller slit collimator of 0.4° acceptance angle, and an Xe proportional detector with a large window detector tube. This is essential for parallel beam use, as the Bragg angle is defined by the Soller collimator. It is used with the Polycapillary Optic and Parallel Mirror Optic and can also be used with the Solid State Detector.

# Interchangeability

# Choice of Stages



## Standard Stage

The standard stage takes the standard 2 inch diameter sample holders, which are spring loaded against height setting pegs precisely adjusted to the goniometer axis.



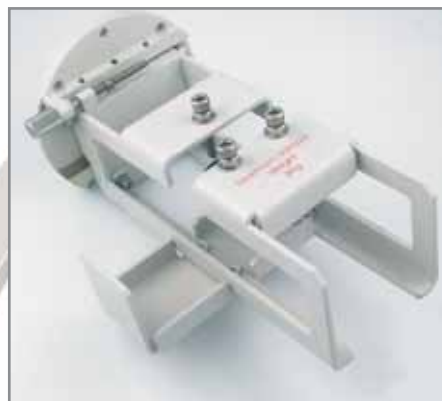
## Long Sample Stage

This stage can also be used for bulk sample applications and can take ingots up to 52 mm diameter and 100 mm long.



## Spinning Stage

A variation on the standard stage; it holds the sample holders up against small ball-bearing rollers which are precisely adjusted to height.



## Large Sample Stage

This stage is for bulk samples and can take large samples up to 150 mm diameter x 20 mm thick. Translation and rotation allows access to the whole surface.

# Flexibility



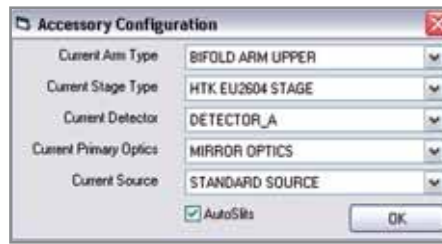
### **PAAR HTK-16 High Temperature Stage**

Allows setting of temperatures up to 1600°C in Vacuum with precise and rapid temperature setting. Software allows setting up of an automated temperature ramping and repeat scan sequence.



### **Auto Loader**

The 10 sample Autoloader includes the option to spin in the analysis position. Random access to any position makes it convenient for permanent mounting and/or use for single samples.



### **Accessory Picker**

Allows rapid interchange between hardware accessories by calling up their individual calibrations.



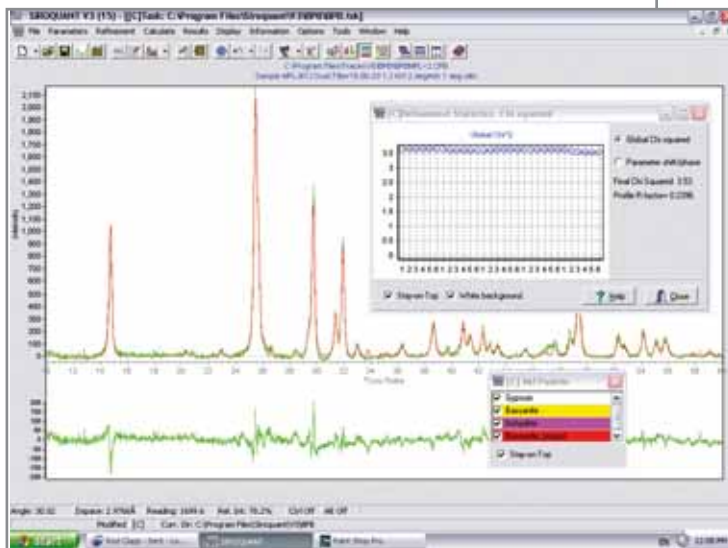
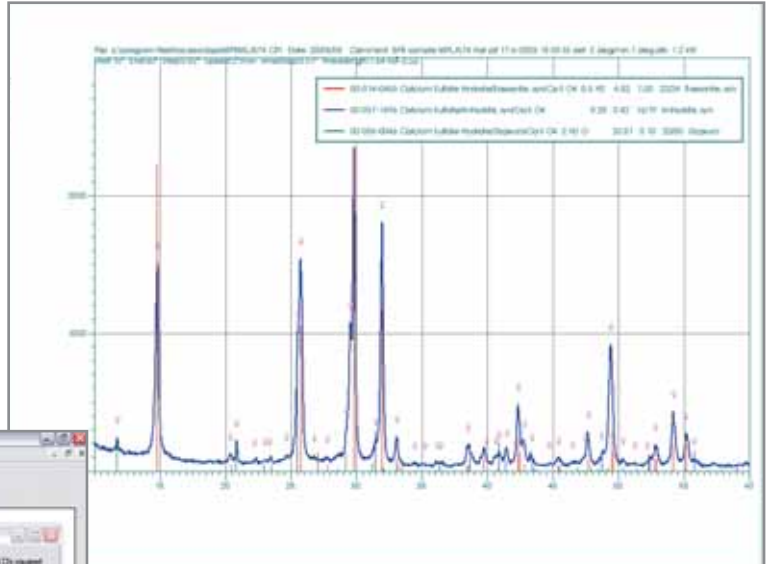
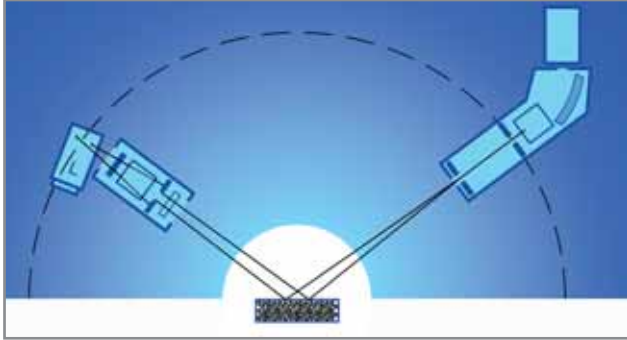
### **Eulerian Cradle**

Essential for Pole Figure data collection and preferable for Residual Stress work. It has a slim cross section, so has minimum obscuration of the detector and maximum available angle.

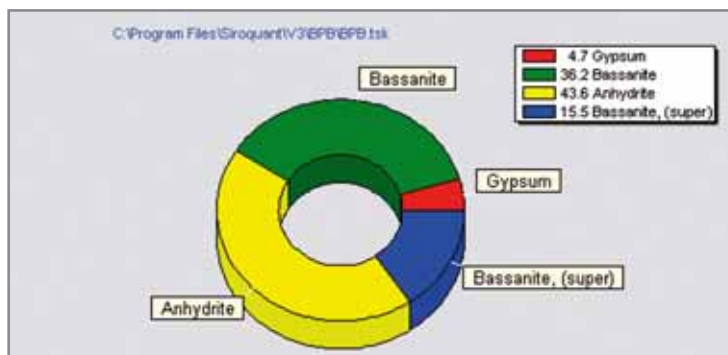
# Versatility

# Qualitative and Quantitative Analysis Application

Qualitative and Quantitative analysis with the Bragg-Brentano focussing geometry, using a Xe detector with graphite monochromator, or a Solid State detector.



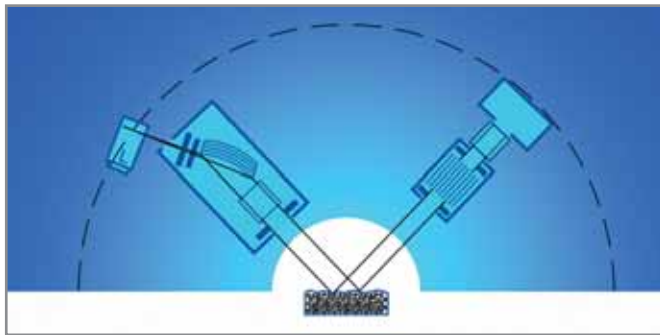
Search match for Qualitative ID of phases, using the DSEARCH option in Traces software, and either a PDF-2 or a PDF-4+ database from ICDD®.



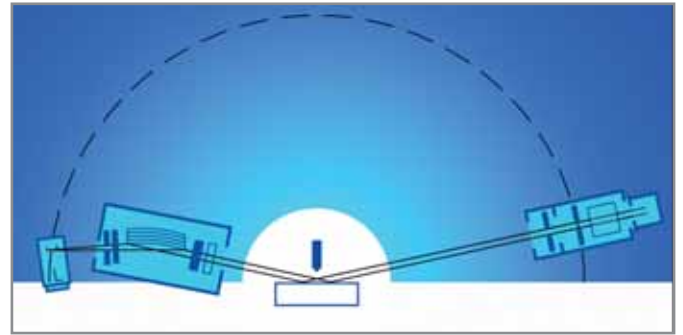
Quantitative Analysis using the Rietveld pattern synthesis quantitative software SIROQUANT®. This application is the analysis of Anhydrite production for Plaster Board manufacture, tracking the kiln dehydration of Gypsum, through Bassanite to Anhydrite.

## Practicality

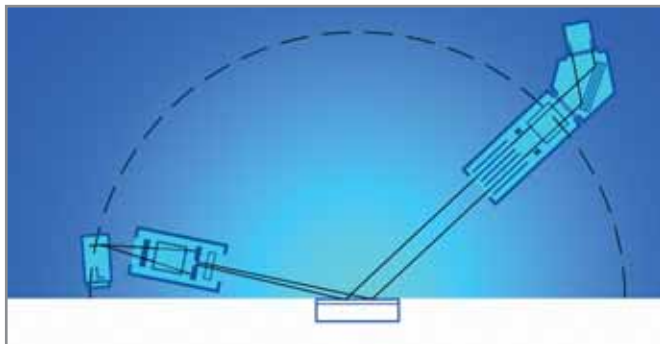
# Thin Film Application



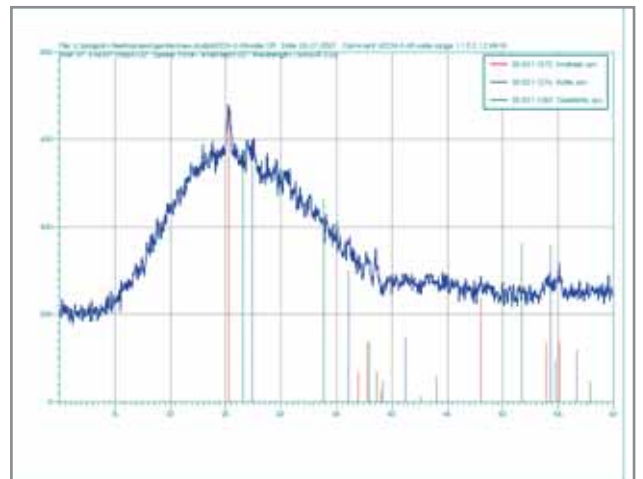
Mirror optic with parallel beam detector



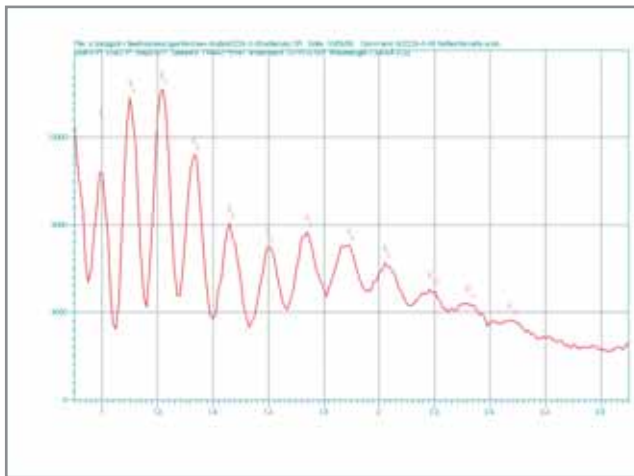
Mirror optic with dual fine slits



Fine slit optic with parallel beam detector



This example shows reflectivity fringes to determine film thickness and a wide range Bragg Brentano scan to identify the phases in the thin films. These films were tri-layers on glass, with approx. 50 nm of  $\text{SnO}_2$  on the glass, then approx. 200 nm of  $\text{TiO}_2$ , then approx. 5 nm of  $\text{SiO}_2$  on top.

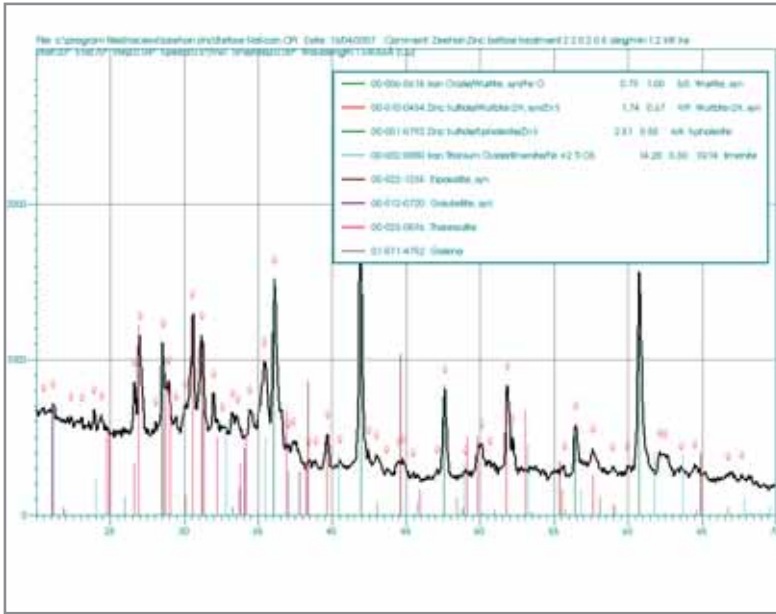


The reflectivity fringes show sets of superimposed periodicities corresponding to the multiple films.

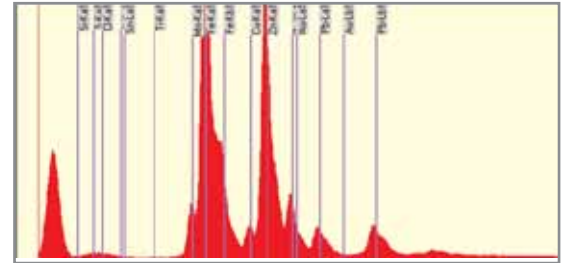
# Sensitivity

# Analysis of Complex Disordered Mixtures

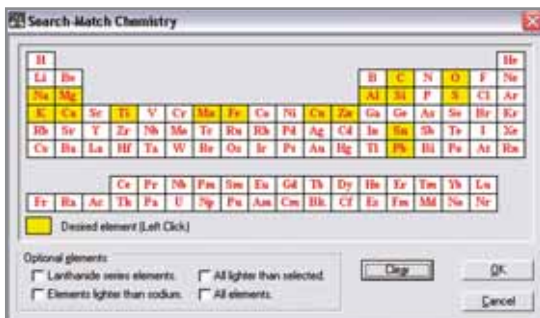
## XRF with the XRD



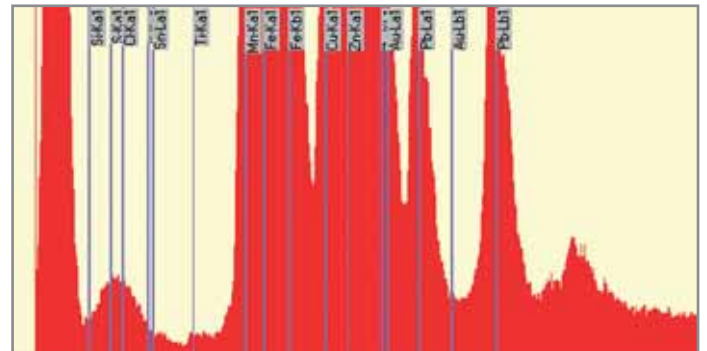
A very complex degraded mixture of minerals giving very ambiguous identification without knowing the chemical composition.



XRF Spectrum obtained with the XRF attachment to the XRD. Scale 10,000 counts, showing major concentrations of Fe and Zn.



Entry of Chemical screening into Traces Search/Match that brings major compounds higher up the match list.



XRF Spectrum obtained with the XRF attachment to the XRD. Scale 1,000 counts, showing minor concentrations of S, Sn, Ti, Mn, Cu and Pb.



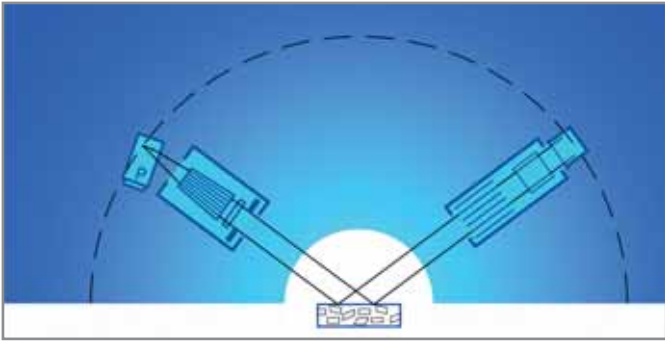
**Polarised Optics XRF Attachment**



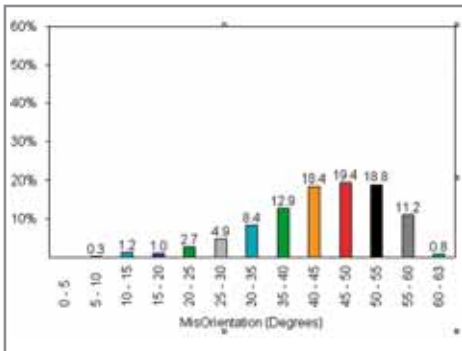
**Over-stage XRF Mounting**

## Real Life Applications

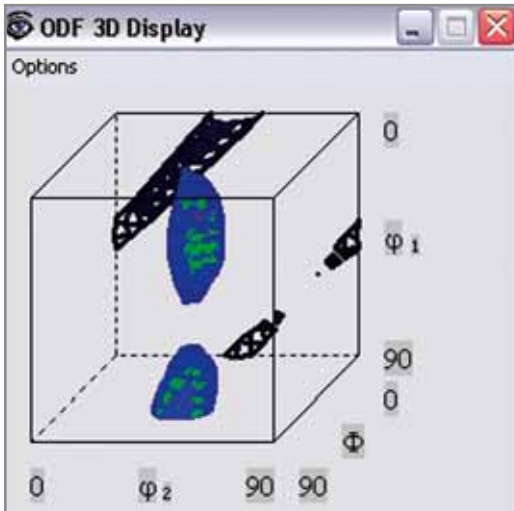
# Enhanced Texture Application



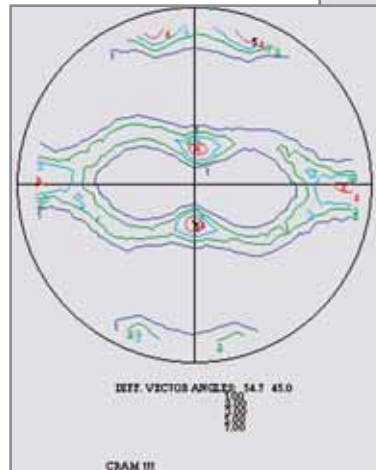
The enhanced texture system includes the unique Slim-line Eulerian Cradle, a Polycapillary Optic and a parallel beam detector. Software to collect pole figures in GBC-Difftech, POPLA\* and ResMat® formats is included.



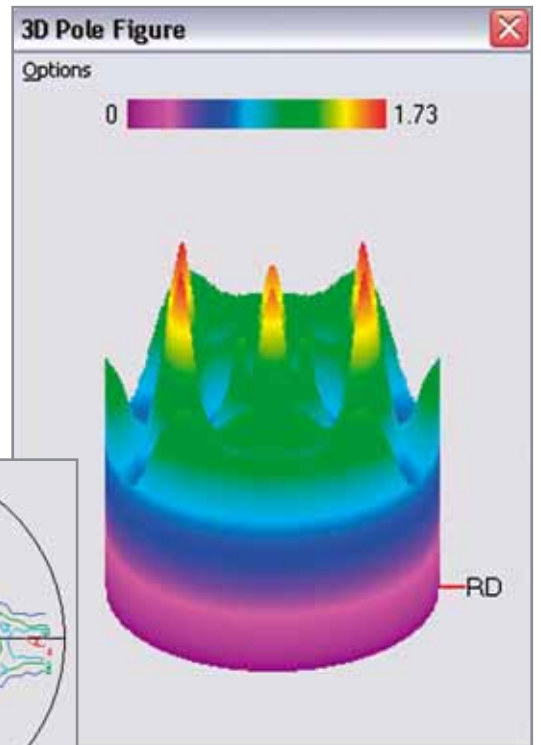
**ResMat Grain Boundary misorientation statistics**



**ResMat 3D Orientation Distribution Function, Cubic Steel**



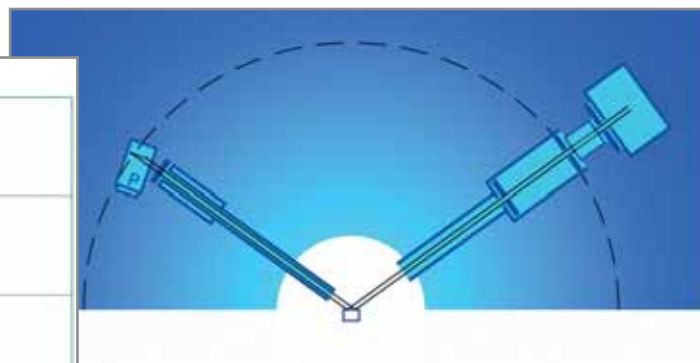
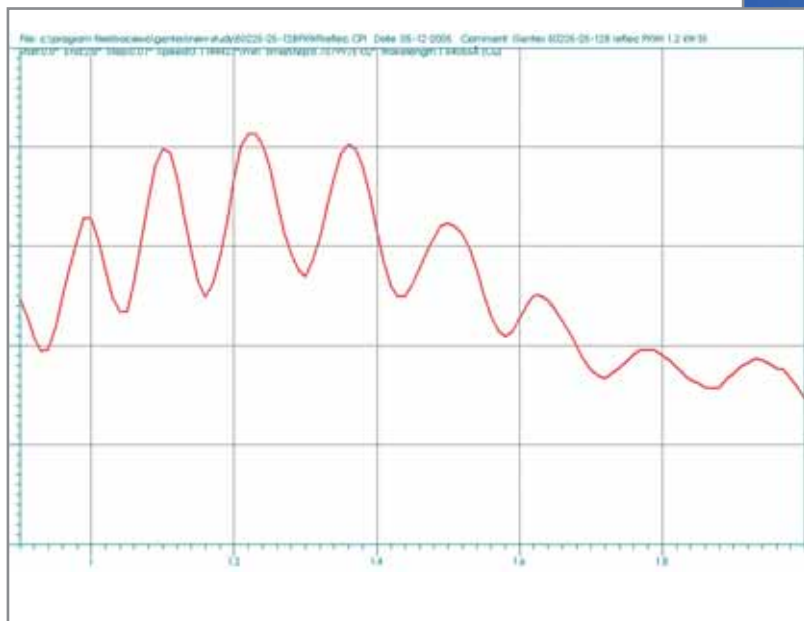
**Basic Format pole figure plot**



**ResMat 3D Pole figure, cubic steel**

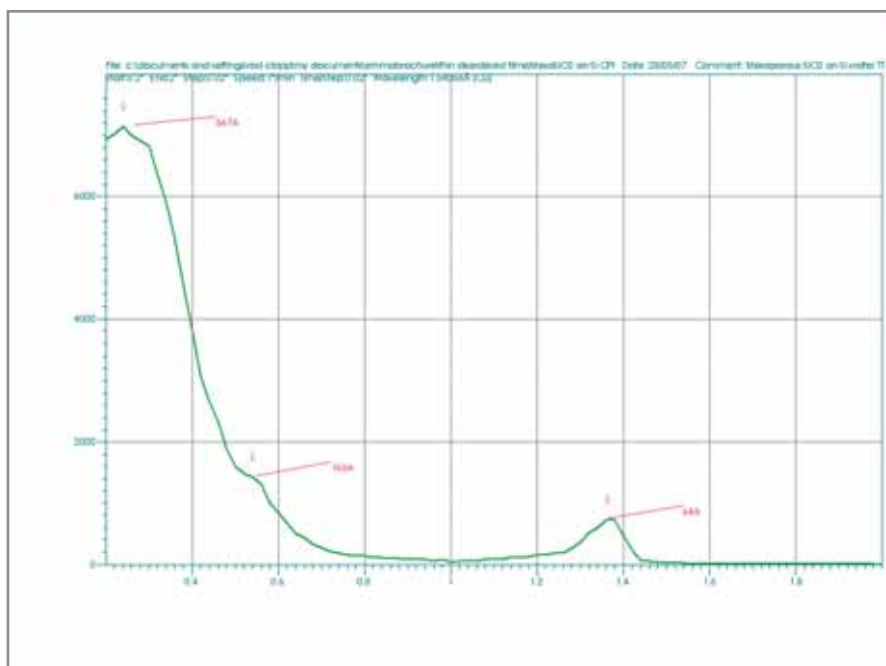
# Advanced Applications

# Analysis of Thin Disordered Films



The PXWR or Planar X-ray Waveguide Resonator is a unique primary beam optic which produces a very thin (100 nm high) nearly parallel beam with enhanced transmission intensity for very low angles (d-spacings up to 300Å) in less - ordered structures.

An example of reflectometry fringes obtained with the PXWR.



Scan starting from 0.2° 2θ on mesoporous SiO<sub>2</sub> showing periodicities up to 367 Angstroms.

## Nano Structures



# Specifications

## Hardware Specifications

### X-ray Generator Type

X-ray Generator Type  
Medium Frequency, IGBT type,  
3kW, 60 kV, 80mA, stability 0.005%  
for 10% change in supply voltage

### X-ray Tubes

Type  
Glass envelope, or Ceramic Envelope  
- Cu Long-Fine Focus ( 0.4 x 12 mm) standard  
- Anodes Cu, Co, Cr, Fe  
- Power 2.2kW for Cu

### Goniometer

Type  
- Twin co-axial Harmonic gearbox  
- Independent axes  
- Minimum step size each axis 0.002°  
- Reproducibility < 0.0001°  
- Zero backlash  
- Radius 180-250 mm  
- Maximum range -30 to +160° depending  
on configuration

### Primary Beam Optics

Types  
- Divergence slit assembly with soller slit  
- Auto slit with soller slit  
- Polycapillary optic for parallel beam  
- Parabolic mirror for parallel beam  
- Confocal mirror for transmission geometry  
- PXWR X-ray waveguide resonator

### Secondary Beam Optics

(Detectors and Optics)  
Types  
- Scatter slit to match divergence slit  
- Auto scatter slit  
- Parallel beam detector with long soller  
- Curved graphite monochromator

### Detectors and Counting Electronics

Types  
- Xe proportional detector for focussing  
geometry with Graphite monochromator

- Xe proportional detector for parallel beam  
geometry  
- Solid-State detector, Si PIN Diode,  
focussing  
- Solid State detector, Si PIN Diode, Parallel  
beam

### Sample Stages

Types  
- Standard stage for 2 inch dia. standard  
holders  
- Spinning stage for 2 inch dia. sample  
holders  
- Eulerian Cradle or Texture Circle,  
slim-line  
- Bulk sample stage, for 150 mm x  
20 mm samples, max weight 3 kg  
- Bulk sample stage for 50 mm x 150 mm  
samples  
- Capillary Spinner stage  
- High Temperature Stage PAAR HTK-16  
- Low Temperature Stage, Peltier-cooled

### Remote Diagnostics

Easy to install, user friendly software  
enables GBC to provide you with  
complete on-line remote instrument  
diagnostics and trouble shooting. The  
EMMA has an IP address, so can be  
driven from anywhere on the internet,  
(firewalls etc. permitting).

### Ancillaries

Closed Circuit Water Chiller  
Polyscience® model 6706 P or equivalent  
cooling capacity 3kW FLOW rate > 4 l/min,  
pressure > 4 bar.

### Dimensions

1100 mm wide x 700 mm depth  
x 1050mm height  
Weight approx. 150 kg  
Packed weight approx. 230 kg

## Software Specifications

### VisualXRD Software

- 32 bit application
- Simple routine operation
- File Save and recall Parameter sets
- Software configuration to set user Folder
- Hardware configuration for Tube Anode
- Accessory configuration to select  
interchangeable options
- Manual control for computer-aided  
alignment
- Pulse Height Analysis used with Xe  
proportional detector
- Data collection modes - Single, Multi Pass,  
multi range,  $\theta/2\theta$ ,  $\theta$  only,  $2\theta$  only
- Continuous, Step scan, Residual Stress,  
Texture (Texture requires VisTex software suite)

### Tracesv6 Software Specifications

- Process scans from Emma and other  
manufacturers
- Tool buttons with tool tips & menus
- Zooming, scrolling and graphical peak  
labeling
- 16 million colours with graphical selection
- Work with up to 50 scans
- 3D Graphics - perspective, trend lines, etc
- Automatic and manual cubic background fit  
& strip
- Export scans in many formats,
- Scan manipulation, add, subtract, trim, spike  
removal
- Smoothing, cubic,  $K\alpha_2$  stripping
- Peak area, with quantitation, Log scale,  
toggle on/off
- Peak FWHM determination, Particle Size by  
Scherrer method
- Search PDF4+, PDF1, PDF2 and PDF4+  
line markers displayed
- Print preview mode 2D and 3D display.
- Print PDF Cards from PDF-2 and PDF-4+
- Line widths, line-styles and fonts selectable
- Powder Pattern Generator
- Peak fitting and deconvolution - Least  
Squares or Genetic algorithm
- Full Windows HELP system and manual included
- All scan colours & PDF stick-figure colours  
preserved

# Comprehensive and Compact

-Common functions by right mouse button click  
-Retained Austenite, with VisualXRD data collection  
-Residual Stress, with VisualXRD data collection

### Options

-DSearch Search/Match against PDF1 extracted from PDF2 or PDF4 + Hanawalt Search with 1 - 9 strongest lines, Chemistry pre-screen,  
-INDEX Indexing of Powder Patterns by the methods of Appleman and Evans, US Dept of Commerce Geologic Div.Nat. Tech Service, 1972.  
-UnitCell - refinement of Unit Cell dimensions using the method of B.Rupp, ref. Scripta Metallurgica 22, 1 (1988).

### Acknowledgements\*

PDF2, PDF4 +  
ICDD International Centre  
for Diffraction data  
12 Campus Boulevard  
Newtown Square PA 19073-3273  
U.S.A.

SIROQUANT  
Sietronics Pty. Ltd  
Unit 3 / 22 Walder Street  
Belconnen A.C.T. 2617 Australia

Resmat Corporation  
Suite 320, 3637 University  
Montreal, QC,  
Canada, H3A 2B3

XOS X-ray Optical Systems Inc.  
15 Tech Valley Drive  
East Greenbush NY 12061 U.S.A.

POPLA Preferred Orientation Program  
Los Alamos  
Materials Science & Technology Div.  
Los Alamos National laboratory  
U.S.A.

PXWR Planar X-ray Waveguide  
Resonator.  
Prof. V.K Egorov.  
Institute of Microelectronics  
Technology  
Russian Academy of Sciences  
Chernogolovka , Moscow 142432  
RUSSIA

Polyscience Inc.  
6600 W. Touhy Ave  
Niles, IL 60714 U.S.A.

Anton Paar GmbH  
Anton-Paar-Str. 20  
A-8054  
GRAZ Austria

### Samples kindly provided by:

Danisco Physical Food Science  
Edwin Rahrs vej. 38  
Braband 8220 DENMARK

Gentex Corp.  
675 N. State Street Zeeland.  
MI 49464 U.S.A.

British Gypsum Ltd.  
East Leake Leicestershire  
LE12 6JU. U.K.

Dr. Mike Bartl  
Dept. of Chemistry and Biochemistry  
University of California  
Santa Barbara CA U.S.A.

### Open Software Policy

GBC has a policy of compatibility and easy transfer of data from Emma applications to many associated data processing applications provided by other vendors. This way we can bring the best of the worlds XRD software to the user.

An example is the integration of ResMat® software into the Texture analysis suite included with Emma Texture packages. Pole figure data is collected in ResMat format , providing raw data files which can be read directly for Texture analysis by the "TexTools®" and "TexViewer®" packages which are a part of ResMat.

Other applications such as SIROQUANT® and other well known Rietveld structure analysis or quantitative analysis packages read EMMA raw data files directly, or files saved in their specific format from Tracesv6. Likewise Tracesv6 reads raw data files created by many other suppliers instruments.

PART NO.	DESCRIPTION
99-0501-00	GBC-Difftech MMA, Theta/2 Theta version. Basic unit includes cabinet with shutter control, tube shield, divergence slit optics, fail-safe warning lamp, X-ray tube Cu as standard goniometer, X-ray Generator, Standard Stage, detector arm, software VisXRD and Traces.
99-0550-00	GBC-Difftech MMA, Theta/Theta version. Basic unit includes cabinet with shutter control, tube shield, divergence slit optics, fail-safe warning lamp, X-ray tube Cu as standard goniometer, X-ray Generator, Standard Stage, detector arm, software VisXRD and Traces.
97-2470-00	Xe Proportional detector for Cu with graphite monochromator, built-in counting electronics and cable set.
97-2473-00	Xe Proportional detector for Co with graphite monochromator, built-in counting electronics and cable set.
95-0656-00	Solid State Si PIN Diode Detector including electronics, mounting arm, electronics mounting, software and cable set.
95-0657-00	Parallel beam solid state Si PIN diode detector, including mounting arm, long sollar slit collimator, cable set collimator, mounting for electronics, software and cable set.
95-0658-00	Parallel beam Xe proportional detector with large window tube, long sollar slit collimator, Ni or Fe filter, built-in counting electronics, mounting arm and cable set.
56-1040-00	Bifurcated arm, 22° angle, for simultaneous mounting of 2 detectors
97-2500-00	Xe proportional detector only. Small window, includes preamp and cable set
97-2673-00	X-ray Tube Cu Anode Long Fine Focus (0.4 mm x 12 mm)
97-2676-00	X-ray Tube Cr Anode Long Fine Focus (0.4 mm x 12 mm)
97-2674-00	X-ray Tube Co Anode Long Fine Focus (0.4 mm x 12 mm)
97-2675-00	X-ray Tube Mo Anode Long Fine Focus (0.4 mm x 12 mm)
97-3784-00	X-ray Tube Fe Anode Long Fine Focus (0.4 mm x 12 mm)
99-0504-00	Auto loader stage includes 10x sample holders, electronics and cable set
97-2472-02	High Temperature Sample Stage (PAAR HTK-16) up to 1600°C in vacuum. Includes Pt heating strip, spare windows, adaption bracket for Emma, water manifold, power supply and auto-incrementing repeat scan software. Recommended for use with Theta/Theta. Vacuum Spinning stage for single samples, step motor driven, includes motor driver Eulerian Cradle for Texture. Includes a set of sample stubs, sample height setting jig, alignment samples, axes 3 and 4 for the controller, Shultz collimator and Difftech texture software
99-0534-00	
95-0659-00	
95-0660-00	Large Sample Stage. Accommodates discs up to 150 mm dia. x 20 mm thick, locate any point for analysis in the beam by rotation and translation.
95-0661-00	Long Sample Stage. Accommodates ingots upto 52 mm dia. x 100 mm thick
95-0664-00	Capillary sample holder with XYZ crystal head and alignment microscope
95-0687-00	Vacuum System for PAAR HTK-16 (PAAR Part No. 58963). Includes turbomolecular and rotary pumps, vacuum hoses, gauges and fittings
97-2474-00	Polycapillary optics, 6 mm diameter (10 mm diameter on request), recommended for texture. Includes X-Y mounting. Must be used with a parallel beam detector
97-3808-00	Parallel beam mirror, Ni/C, suppresses Cu Kβ. Includes tube-shield mounting and tube shield angle offset bracket. Can be used with parallel beam detector or dual fine slits.
97-3808-01	Confocal Mirror W/Si includes tube-shield mounting and tube shield angle offset bracket. Used with focussing detector
97-3765-00	PXWR Optic. Includes mounting and alignment. Can be used with a parallel beam detector or dual fine slits
54-0603-00	Holder, Std. Powdered Sample, eMMA 1.8 mm deep
54-0605-00	Holder, Std. Powdered Sample, eMMA 0.8 mm deep
54-0606-00	Holder, Std. Powdered Sample, eMMA 0.2 mm deep
54-0604-00	Holder, Low Background, eMMA
81-1506-00	Holder Std. eMMA Autoloader
97-3816-00	Holder Thin Film Sample Holder precision adjustable
99-1474-00	Water Recirculator, 240V/50 Hz
99-1474-01	Water Recirculator, 208-230V/60 Hz
99-0510-00	Base cabinet on castors for attaching to MMA standard cabinet
95-0666-00	Autoslits available for divergence and scatter positions (for eMMA only)
95-0667-00	XRF Attachment including AmpTek AXR-CR detector with PA210 preamp, USB interface, power supply and DP4 processor with software. Includes both over-stage mounting and polarised optics attachment for divergence slit mounting.
95-0573-00	Software kit Tracesv6.7 and upgrade, distribution and manuals
31-0255-00	Software distribution VisXRD and Tracesv6.7 for eMMA
31-0256-00	Software distribution Traces v6.6 for ICDD PDF-2 prior to release 2005
95-0678-00	Software Site License Tracesv6
31-0275-00	Software MNI Mean Normalised Intensity software, uses I/lc ratios in PDF2 and PDF4+.
31-0345-00	Software ResMat XRD Texture Analysis Software
31-0279-00	Software ICDD PDF-4 Minerals Subfile - Commercial (1 year license).
31-0279-01	Software ICDD PDF-4 Minerals Subfile - Academic (1 year license).
31-0277-00	Software ICDD PDF-4+ Commercial (1 year license).
31-0277-01	Software ICDD PDF-4+ Academic (1 year license).
31-0280-00	Software ICDD PDF-2 Commercial (5 year license).
31-0280-01	Software ICDD PDF-2 Academic (5 year license).
31-0352-00	Software ICDD SIEVE+ Support for PDF-4+ Commercial.
31-0351-00	Software ICDD SIEVE+ Support for PDF-4+ Academic.
31-0347-00	Software ICDD Suite SIEVE with DDVIEW Support Software for PDF-2 - Commercial
31-0340-00	Software ICDD Suite SIEVE with DDVIEW Support Software for PDF-2 - Academic.
31-0356-00	Software ICDD PDF-4 Minerals Subfile - Annual Renewal - Commercial.
31-0355-00	Software ICDD PDF-4 Minerals Subfile - Annual Renewal - Academic.
31-0350-00	Software ICDD DDVIEW Support for PDF-2 - Commercial.
31-0349-00	Software ICDD DDVIEW Support for PDF-2 - Academic.
31-0353-00	Software, PDF-1 Preparation Charge Only for PDF-4+. The price applies only if PDF-4+ and DSearch option is purchased. This PDF-1 is subject to the same time-lock as the PDF-4. This PDF-1 must be used on the same PC as the PDF-4
31-0346-00	Software, PDF-4+ Annual Renewal Fee - Commercial.
31-0357-00	Software, PDF-4+ Annual Renewal Fee - Academic.
31-0354-00	Software, PDF-1 Preparation Charge Only for PDF-2. The price applies only if PDF-2 and DSearch option is purchased. This PDF-1 is subject to the same time-lock as the PDF-2. PDF-1 must be used on the same PC as the PDF-2.

Designed and manufactured by  
GBC Scientific Equipment Pty Ltd  
A.C.N. 005 472 686

GBC reserves the right to  
change specifications without  
prior notice.

GBC publication number  
01-0924-01 July 2007 Australia

## GBC SCIENTIFIC EQUIPMENT

Manufacturer of world-class  
scientific instruments and  
accessories :AAS, HPLC, ICP-  
OES, ICP-oTOFMS, Rheometry,  
UV-Vis and XRD

12 Monterey Road  
Dandenong, Victoria 3175  
Australia

Telephone 61 3 9213 3666  
Facsimile 61 3 9213 3677  
email gbc@gbcsci.com  
URL www.gbcsci.com

All trade-marks and trade-names  
are the property of their  
respective owners.



Front Cover contains a  
structure diagram created by  
the ICDD PDF4+ 3D  
structure visualiser, showing  
a 3D cell projection. The  
powder pattern is from  
ICDD data source 4 , the  
LPF Collection , Code  
125089, Calculated pattern.  
Original publication was  
"Silicon-Oxygen Bond  
Lengths, Bridging Angles Si-  
O-Si and Synthetic Low  
Tridymite". Baur W.H. Acta  
Cryst. Section B ( 1976) 32,  
2486-2491.



**GBC**  
SCIENTIFIC EQUIPMENT