# MiniFlex™

## MATERIALS ANALYSIS BY X-RAY DIFFRACTION

Rigaku®
POWERING NEW PERSPECTIVES

ADVANCED BENCHTOP
X-RAY DIFFRACTOMETER

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## MiniFlex

More power. More Flexibility. More results.

# SIXTH GENERATION BENCHTOP X-RAY DIFFRACTOMETER

### RIGAKU'S MiniFlex BENCHTOP XRD REDEFINES X-RAY DIFFRACTION

X-ray diffraction (XRD) is a powerful and well-established technique for analyzing materials. Industries as diverse as cement, catalysis, petroleum, energy and pharmaceuticals rely on XRD to characterize materials from basic research all the way to quality control. It is also an important scientific technique taught to students who study geology, material science, chemistry and crystallography.

Rigaku's MiniFlex is a fully featured, general purpose X-ray diffractometer. It can perform qualitative and quantitative analysis of polycrystalline materials. In qualitative analysis, the instrument is used to identify unknown substances (chemical compounds or "phases") by comparing experimental diffraction data against a database of known phases. In quantitative analysis, it is used to characterize solid mixtures to determine relative abundance of crystalline compounds.

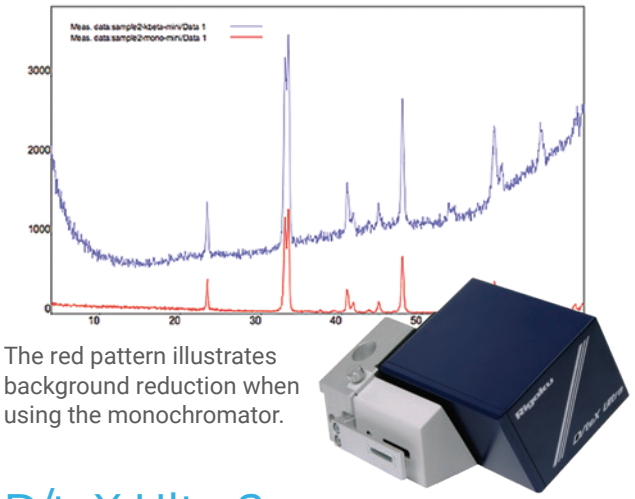
**Sixth generation MiniFlex retains the characteristics that have made it popular for so many years:**

- Compact size allows it to be installed on a lab bench
- Half the cost of a traditional floor-standing diffractometer
- Distinguished scientific literature record
- Easy to use, operate, and maintain
- Able to use pre-existing utilities
- 600 W of X-ray tube power

**The latest version has advanced features and options that deliver powerful capability, including:**

- XSPA-200 ER – 2D hybrid pixel array detector
  - Acquire data in 2D, 1D or 0D modes
- D/teX Ultra2 – 1D advanced silicon strip detector
  - Uniquely available with receiving monochromator
- ASC-8 – unique 8-position sample changer

# TWO DETECTOR CHOICES



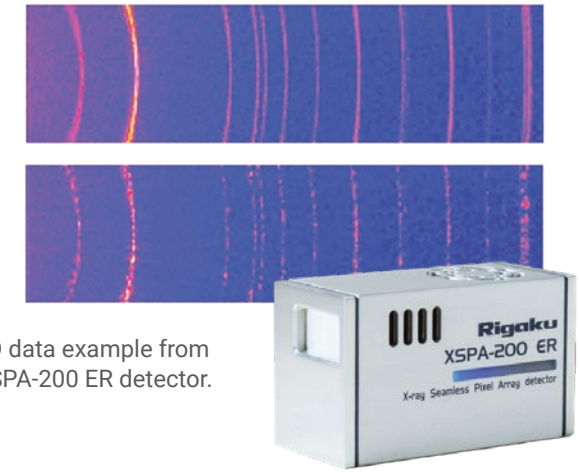

The red pattern illustrates background reduction when using the monochromator.

## D/teX Ultra2

### 1D SILICON STRIP DETECTOR

MiniFlex is equipped with the D/teX Ultra2 high-speed 1D (one dimensional) silicon strip detector to obtain intensity a few tens to roughly 100 times greater than a conventional scintillation counter. D/teX Ultra2 measures data faster because it can measure a wide range of 2θ simultaneously with high angular resolution.

D/teX Ultra2 may be operated in 0D mode, equipped with an optional graphite monochromator (shown above) to maximize sensitivity by optimizing peak-to-background ratios. In addition, this option eliminates fluorescence from materials containing Fe, Ni, Co and Mn.



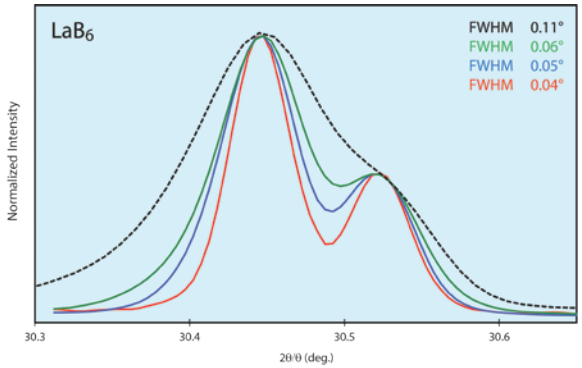

2D data example from XSPA-200 ER detector.

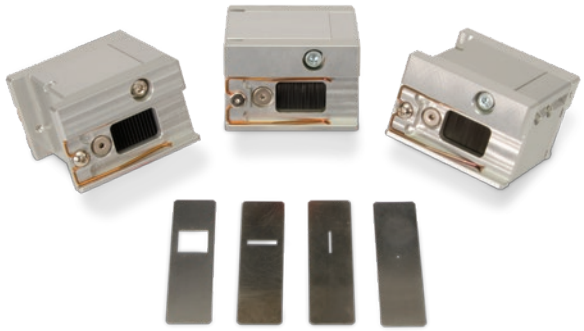
## XSPA-200 ER

### 2D HYBRID PIXEL ARRAY DETECTOR

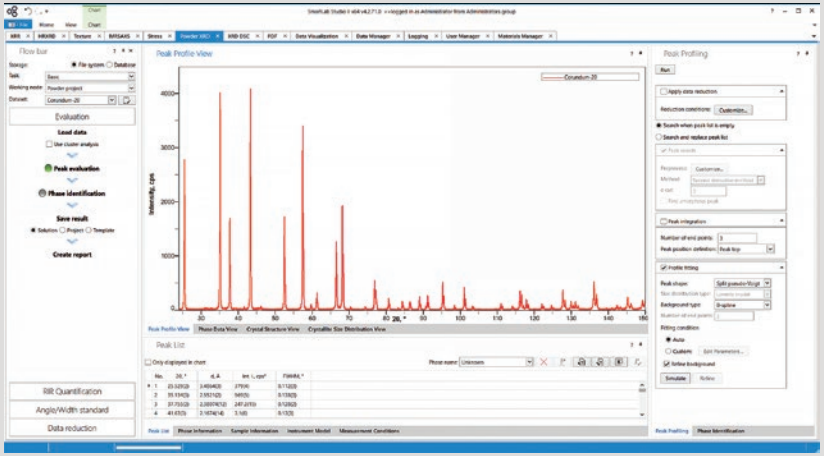
The MiniFlex can also be configured with the XSPA-200 ER hybrid pixel array detector (HPAD) featuring the highest energy resolution available in a 2D detector for benchtop systems at 340 eV. This new direct photon counting detector enables high-speed, high-dynamic range, low-noise data collection in 0D, 1D and 2D modes. This highly versatile detector is ideal for the widest range of applications, including conventional powder XRD, and can reduce background noise on highly fluorescent materials improving P/B ratio by up to 3X.

### CHOICE OF OPTICAL COMPONENT FOR OPTIMAL RESOLUTION



# ANALYSIS SOFTWARE



SmartLab Studio II is a new software package with a user-friendly GUI that integrates all measurements and analyses. Users can choose desired modules from various plugins, such as “XRD Measurement,” “Powder XRD,” and “Data Manager,” and operate them on a single platform with an improved analysis environment and operability.

SmartLab Studio II employs a workflow bar to guide users through the necessary steps from setup and measurement to analyzing and reporting, so instrument operation is always straightforward.

**SmartLab Studio II has a rich feature list:**

- Search/match analysis
- Percent crystallinity
- Cell refinement
- Indexing
- *Ab initio* structure solving
- Quantitative analysis
- Crystallite size and strain
- Whole pattern profile fitting
- Rietveld refinement
- Lattice parameter refinement

# OPTIONS AND ACCESSORIES


## D/teX Ultra2: 1D Si STRIP DETECTOR

High-speed, 1D silicon strip detector standard for fast, high-resolution scanning in 0D and 1D modes.

## SAMPLE SPINNER

The sample spinner allows continuous rotation to minimize the effects of preferred orientation.

## GRAPHITE MONOCHROMATOR FOR THE D/teX Ultra2

The graphite monochromator optimizes sensitivity by lowering the background level. It improves signal to noise by eliminating fluorescence from materials containing Mn, Fe, Co and Ni.

## XSPA-200 ER: 2D HPAD DETECTOR

Optional advanced hybrid pixel array detector (HPAD) with zero background noise, an active area of 200 $mm^2$, spatial resolution of 75 µm, and maximum count rate of $10^6$ cps/pixel or more. XSPA-200 ER can operate in 0D, 1D or 2D modes with up to 340 eV energy resolution.

## BTS 500 AND BTS 150 HEATING AND COOLING TEMPERATURE ATTACHMENTS

The high temperature attachment can heat a sample to perform in situ powder diffraction measurements under high temperature conditions from ambient to 500°C.

## ASC-8 AUTOMATED SAMPLE CHANGER

Automatic 8-position sample changer with spinner.

## SAMPLE HOLDERS

Various sample holders are available to meet the specific needs of each lab.

## AIR-SENSITIVE SAMPLE HOLDER

An air-sensitive sample holder is available for users studying materials that might degrade in the presence of air.

Co-crystals and polymorphs

Exploration and petrochemicals

Geology, mining and cement

QC, corrosion and failure analysis

Paints and coatings

Forensics and chemistry

Cosmetics and food science

# SMARTLAB STUDIO II SOFTWARE

SmartLab Studio II is a new Windows®-based software suite developed for the flagship Rigaku SmartLab X-ray diffractometer that integrates user privileges, measurements, analyses, data visualization and reporting. Newly available for the MiniFlex, the modular (plugin) architecture of this software delivers state-of-the-art interoperability between the functional components. Just one click switches from measurement to analysis. Watch real-time scans from one experiment while simultaneously analyzing other data on the same desktop by selecting an appropriate layout. The software provides various analysis tools such as automatic phase identification, quantitative analysis, crystallite-size analysis, lattice constants refinement, Rietveld analysis, ab initio structure determination, etc.

## POWDER XRD: PHASE IDENTIFICATION WITH A VARIETY OF AVAILABLE DATABASES[*1]

Peak position, FWHM, integrated intensity and crystallite size are calculated by profile fitting. Rigaku's optional "Hybrid Search/Match" uses peak-base qualification, which detects heavily distorted lattices to identify solid solution phases that are difficult to identify. It also can determine whether preferred orientation exists based on decomposed peak intensities.

## POWDER XRD: QUANTIFICATION PACKAGE

This option supports internal standard, external standard, and standard addition calibration methods. Calibration curves are used to quantify specific phases in the sample.

## POWDER XRD: COMPREHENSIVE ANALYSIS PACKAGE

This optional package can provide analysis results such as crystalline size, lattice strain, lattice parameters refinement, %crystallinity based on fully automated profile fitting executed after loading measured data. Results obtained aid in understanding the relationship between structure and physical properties, and allow users to compare results across different samples.

| Database name | Contents | Number of entries[*2] | Structure parameters[*3] | License term[*4] |
|---|---|---|---|---|
| ICDD PDF-2 | Inorganic and organic compounds | 349,000+ | None | 5 to 10 years |
| ICDD PDF-5+ [*1] | Inorganic and organic compounds (minerals) | 1,000,000+ | 60% | 1 year subscription |
| ICDD PDF-4 / Minerals | Mainly inorganic compounds (minerals) | 51,000+ | 80% | 1 year subscription |
| ICDD PDF-4 / Axiom | Mainly inorganic compounds | 108,000+ | 75% | 3, 6, or 9 years |
| COD | Inorganic compounds 25%, organic 75% | 510,000+ | 100% | Unlimited (Free of charge) |

*[*1] Both Single License and Server Edition supported.*

*[*2] Number of entries are as of 2024.*

*[*3] The rate of structure parameters stored in each database.*

*[*4] Each database may be renewed.*

*[*5] This requires a PDF-4 or 5+ subscription.*

## POWDER XRD: DIRECT DERIVATION ANALYSIS PACKAGE

The direct derivation (DD) method was invented by Professor Hideo Toraya of Rigaku Corporation in 2016. It quantifies phases from all integrated diffraction intensities and the chemical formulas of each phase found. Compared to the classical RIR method, where a single integrated peak intensity and RIR number are used, the DD method is less affected by preferred orientation and peak overlap.

## POWDER XRD: RIETVELD ANALYSIS PACKAGE

The package performs phase identification followed by Whole Powder Pattern Fitting (WPPF). The Rietveld analysis refines crystal structure or quantifies the phases directly from measured data, requiring neither reference samples nor a calibration curve. The whole powder pattern decomposition (Pawley method) is based on both the measured peak positions, and peaks shapes.

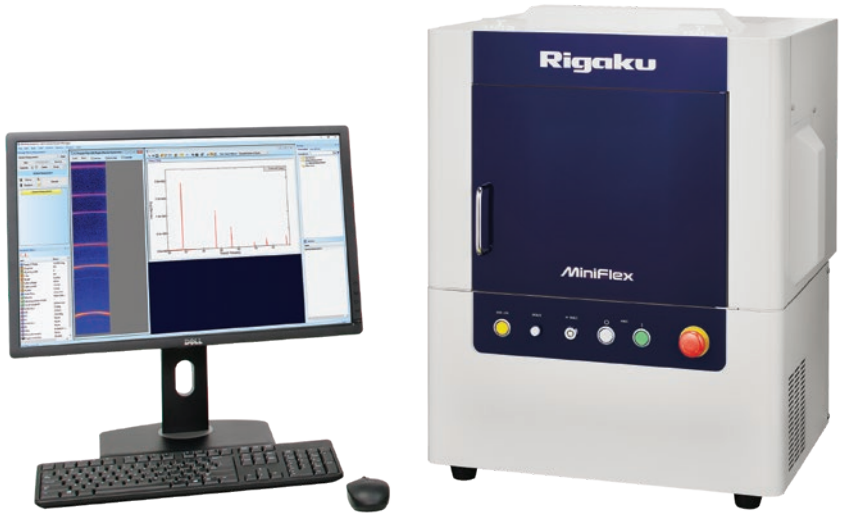
## LEGACY OF INNOVATION

The Rigaku MiniFlex X-ray diffractometer is historically significant in that it was the first commercial benchtop (tabletop) X-ray diffraction instrument. When introduced in 1973, the original MiniFlex XRD was about one-tenth the size of, and dramatically less expensive than, conventional X-ray diffraction (XRD) equipment of the period. The original instrument (Gen 1), and its successor that was introduced in 1976 (Gen 2), employed a horizontal goniometer with data output provided by an internal strip chart recorder. The third generation (Gen 3) instrument, introduced in 1995, was called MiniFlex+. It provided a dramatic advance in X-ray power to 450 W (by operating at 30 kV and 15 mA) and Windows PC computer control. Both the MiniFlex+ and the succeeding generation products employ a vertical goniometer and allow the use of an automatic sample changer. The fourth generation (Gen 4) MiniFlex II instrument was introduced in 2006 and offered the advance of a monochromatic X-ray source and a D/teX Ultra 1D silicon strip detector. The fifth generation (Gen 5) MiniFlex600 system, introduced in 2012, built upon this legacy with 600 W of available power and new PDXL powder diffraction software.

# SPECIFICATIONS

| Specifications | | |
|---|---|---|
| **Software** | Control | SmartLab Studio II |
| | Data analysis | SmartLab Studio II |
| **Generator** | Maximum power | 600 W |
| | Tube voltage | 40 kV |
| | Tube current | 15 mA |
| | Shutter | Rotary shutter linked to interlock |
| | X-ray tube | Cu |
| **Optics** | Divergence slit | Fixed or Variable |
| | Scattering slit | Fixed |
| | Receiving slit | Fixed |
| | Filter | $K_\beta$ Foil filter |
| **Goniometer** | Type | Vertical |
| | Radius | 150 mm |
| | Scanning range | -3 to 145° (θ-2θ) |
| | Scanning speed | 0.01 to 100°/min (2θ) |
| | Minimum step width | 0.005° (2θ) |
| | Accuracy | ±0.02° |
| **Detector** | D/teX Ultra2 | 1D High-speed silicon strip detector |
| **Power** | MiniFlex600 | 1φ AC100 to 240 V ±10%<br>50/60 Hz ±1% 1.0 kVA |
| | MiniFlex600-C | 1φ AC100 to 240 V ±10%<br>50/60 Hz ±1% 1.1 kVA |
| | PC | 1φ AC100 to 240 V ±10%<br>50/60 Hz ±1% 0.7 kVA |

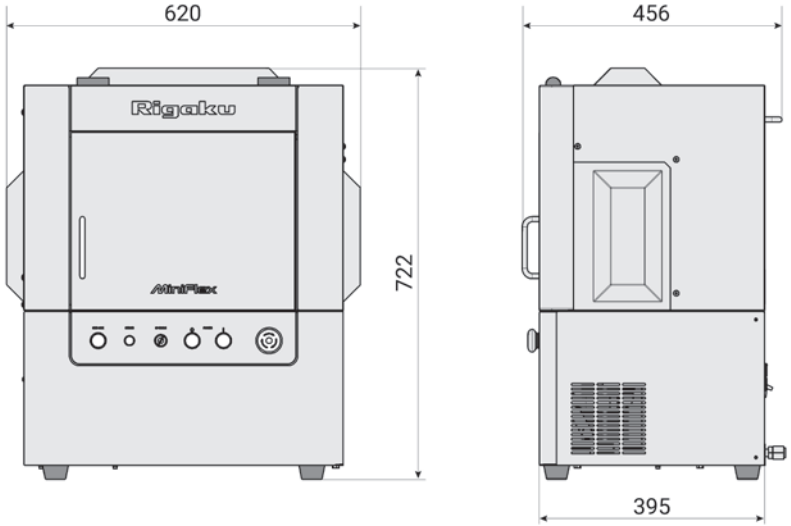
| Specifications | | |
|---|---|---|
| **Options** | X-ray tube | Co, Fe or Cr |
| | Attachment | Sample spinner<br>Automatic sample changer for 8 samples<br>BTS 150, BTS 500 temperature attachment |
| | Sample holder | Air-sensitive sample holder<br>Zero background sample holder<br>Bulk sample holder |
| | Monochromator | Graphite for detector |
| | Detector | XSPA-200 ER 2D hybrid pixel array detector |



# VERSIONS

## MiniFlex600

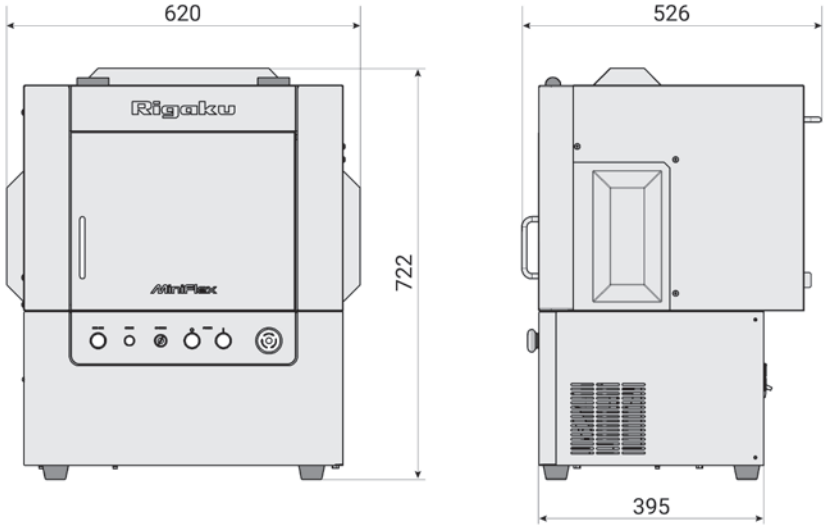
External chiller




Weight: ~80 kg

## MiniFlex600-C

Internal chiller




Weight: ~90 kg

Unit: mm

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