

XRD-6000

Shimadzu
X-ray Diffractometer





**A general purpose
X-ray diffractometer to fulfill your varying
analytical needs
XRD-6000**

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Shimadzu X-ray Diffractometer

Ease of use and abundant functions herald a new era of analysis

The Windows XP-supported application software usher this compact, multi-functional, general purpose X-ray Diffractometer into the networking era of analysis.

With its basic ease of use and abundant functions, the XRD-6000 boasts an integrated design featuring a vertical goniometer and data processing software supporting the Windows XP user interface.

The XRD-6000 offers solutions encompassing wide-ranging analysis requirements, from routine qualitative and quantitative analysis to state change analysis, including stress analysis, residual austenite quantitation, crystallite size/lattice strain, crystallinity calculation, materials analysis via overlaid X-ray diffraction patterns, enhanced material evaluation and sample heating analysis.

And, of course, crystalline structural analysis is also supported, including precise lattice constant determination and crystal system determination.

Features

High-precision built-in vertical goniometer

This can measure various samples including hard-to-secure samples like powders and thin films as well as highly soluble samples.

Windows XP employed as software platform

The main unit control and data processing software supports the widely used Windows XP user interface. For this reason, data can export to marketed software, network support, and multi-user accessibility is easily achieved.

Multi-functional auto-search/match software (qualitative analysis) equipped as standard

The XRD-6000 is equipped with auto-search / match software as standard to aid qualitative analysis - the important analysis task of X-ray diffraction. The detailed search parameter settings, second search function, and the comparison display of candidate substances on raw data profile make analysis easy to understand for even the beginner, and - what is more - a greater success ratio in results can be achieved with the system. In addition, an easy quantitative calculation function and a function that incorporates element data from the X-ray fluorescence spectrometer are also included in the system.

Routine performance maintenance for device is easy

Adjustments to the optical system are performed by automatic setting function. And as the XRD-6000 has a function to automatically save the system's adjustment parameters, system status can be monitored and recorded. Consequently, routine performance maintenance can be easily controlled.

Distinguished body that is safe and compact

The main body has been massively slimmed down (30% reduction in installation surface area compared to previous Shimadzu diffractometers), and as the rear is a sheer flat surface with no superfluous protrusions, the device can placed up against walls, which means it does not take up room when installed on site or in the lab. The unit is also specifically designed to promote ease of handling in sample loading and positioning, and together with the door lock mechanism engaged during X-raying, provides a safe operating environment.

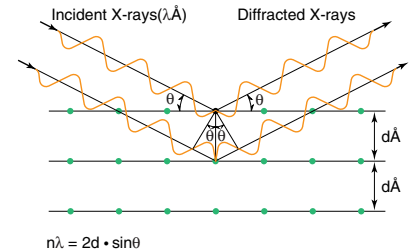
Contents

P 04 - XRD-6000 Features and Applications	P 14 - Options	P 23 - Main Specifications
P 06 - Principle and Construction	P 21 - Other Options	P 24 - Installation Requirements
P 08 - Analysis and Standard Data Processing Functions	P 22 - System Configuration and Accessories	

A general purpose X-ray diffractometer

Principle of operation

The XRD-6000, an X-ray diffractometer analyze crystalline states under normal atmospheric conditions. This method is non destructive. X-rays focused on a sample fixed on the axis of the spectrometer (goniometer) are diffracted by the sample. The changes in the diffracted X-ray intensities are measured, recorded and plotted against the rotation angles of the sample. The result is referred to as the X-ray diffraction pattern of the sample. Computer analysis of the peak positions and intensities associated with this pattern enables qualitative analysis, lattice constant determination and/or stress determination of the sample. Qualitative analysis may be conducted on the basis of peak height or peak area. The peak angles and profiles may be used to determine particle diameters and degree of crystallization, and are useful in conducting precise X-ray structural analysis.



Applications

Steels, non-ferrous metals, machinery, shipbuilding, welding, automobiles, ceramics, cement, glass, catalysts, electrical parts, electronic materials, magnetic materials, superconductive materials, fibers, paper, pulp, food products, chemicals, agricultural chemicals, dies, pigments, paints, pharmaceuticals, dental materials, biological matter, petroleum, coal, power generation, natural gas, mining ore, soil, rocks, clay, minerals, construction, civil engineering, environment, and industrial waste

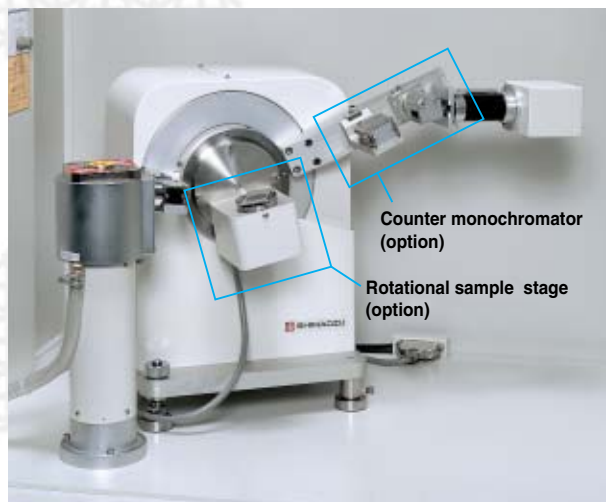
Construction

Compact, X-ray-protected housing

The compact construction (W900xD700xH1600mm) minimizes installation space requirements. The front door is mounted on guide rollers to enable extremely light-touch and smooth door opening for facilitative installation/exchange of samples and attachments. A magnet latch assures certain door closing, and to further ensure safety, a door interlock mechanism is automatically activated whenever X-rays are generated.

High-precision, vertical goniometer

High-speed rate (1000°/min) and high-precision angle reproducibility ($\pm 0.001^\circ$) provide fast measurement and highly reliable data. The vertical goniometer unit allows analysis of samples in various states, substantially widening the application range. The drive mechanism features an independent dual axis θ - 2θ linkage drive, and independent 2θ and θ axis drives, freely selectable for efficient thin film and various other types of analysis.



Vertical Goniometer

to fulfill your varying analytical needs

Construction

High voltage transformer for high output X-ray tube

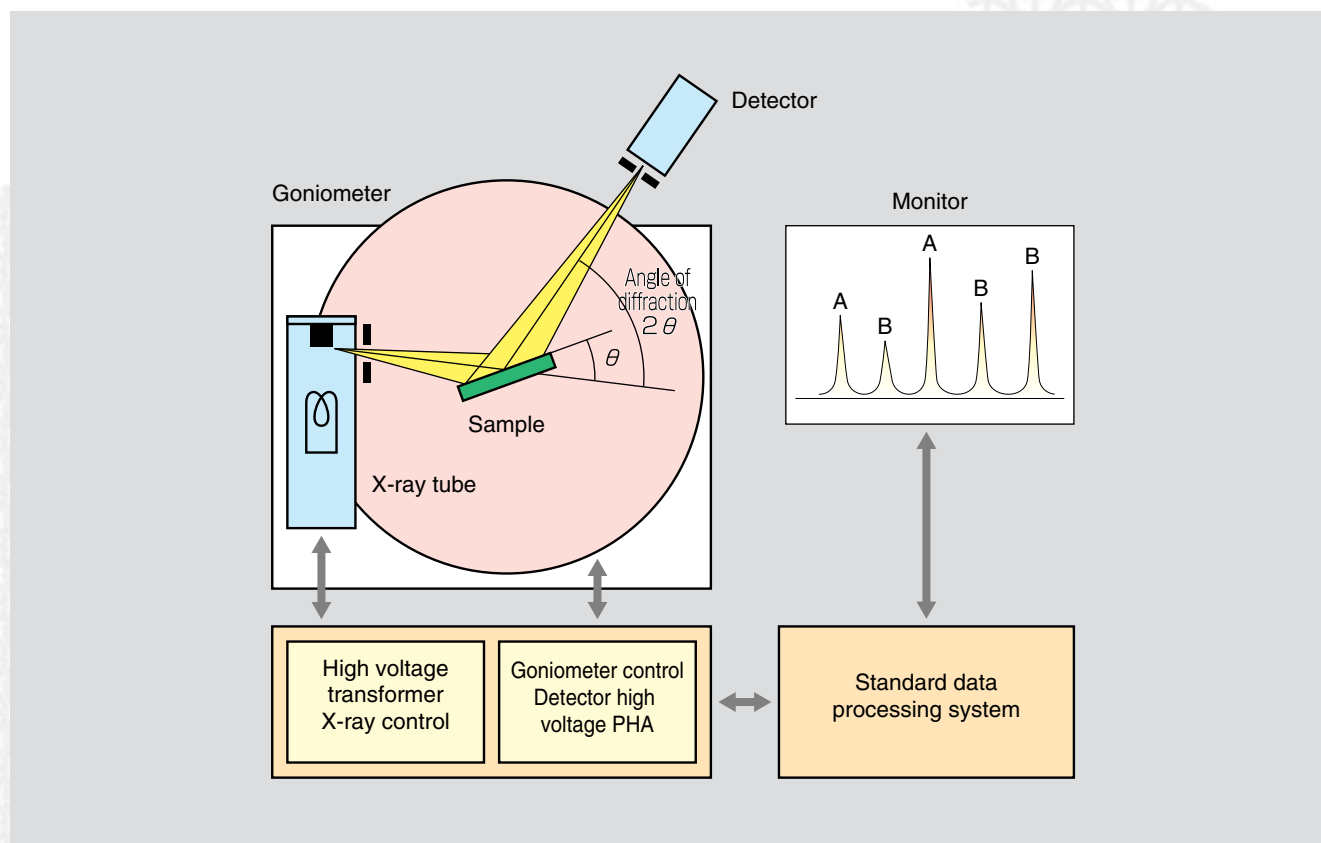
The high voltage transformer supports either the 2.2kW high output fine focus X-ray tube or 2.7kW high output broad focus X-ray tube.

X-ray tubes

The XRD-6000 will accept various types of X-ray tubes, including the normal focus (NF) 2kW type and broad focus (BF) 2.7kW type, which are standard accessories, as well as the optional long fine focus (LFF) 2.2kW type. By attaching the optional counter monochromator, all types of samples, including Fe samples can be analyzed using the standard Cu X-ray tube.

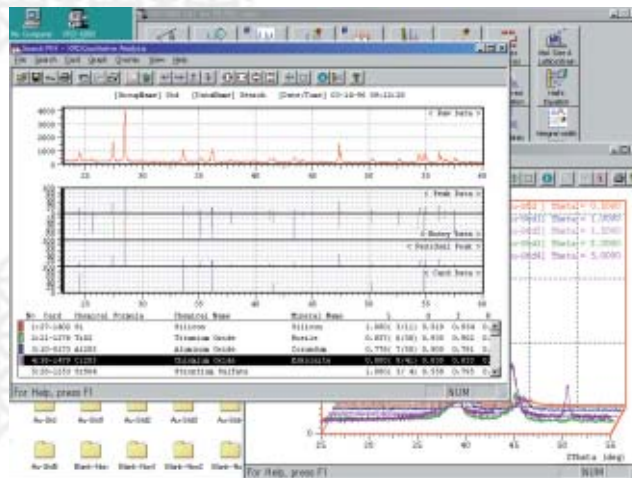
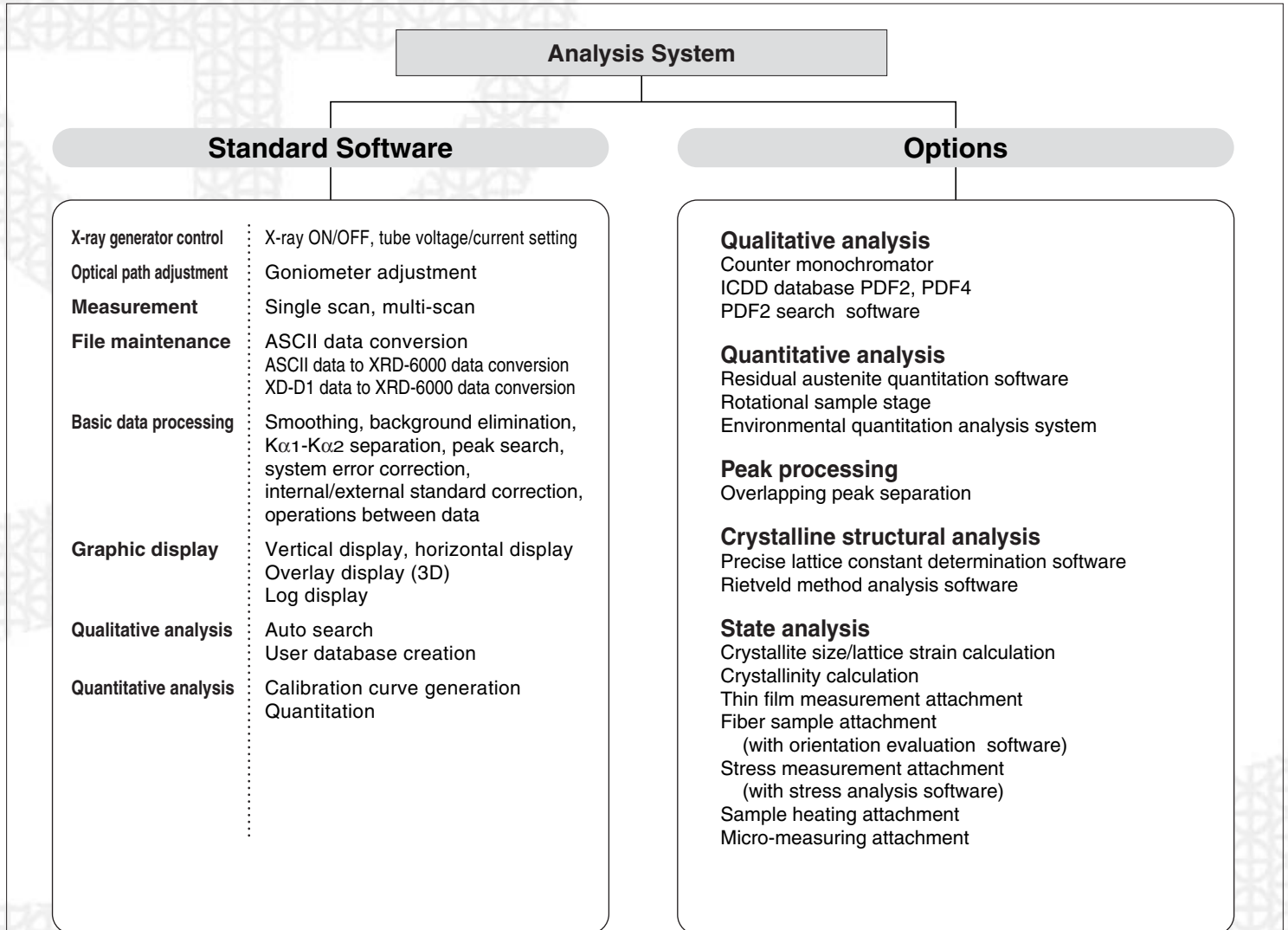
Highly stable X-ray generator

Shimadzu's long experience in producing high-performance X-ray generators has provided an X-ray generator of high stability, with tube voltage and tube current both stable to within $\pm 0.01\%$. This stability is unaffected during fluctuation of source voltage or ambient temperature, ensuring high reliability of data even during prolonged periods of data acquisition.



XRD-6000 Relational Diagram

Providing a Complete Analysis System



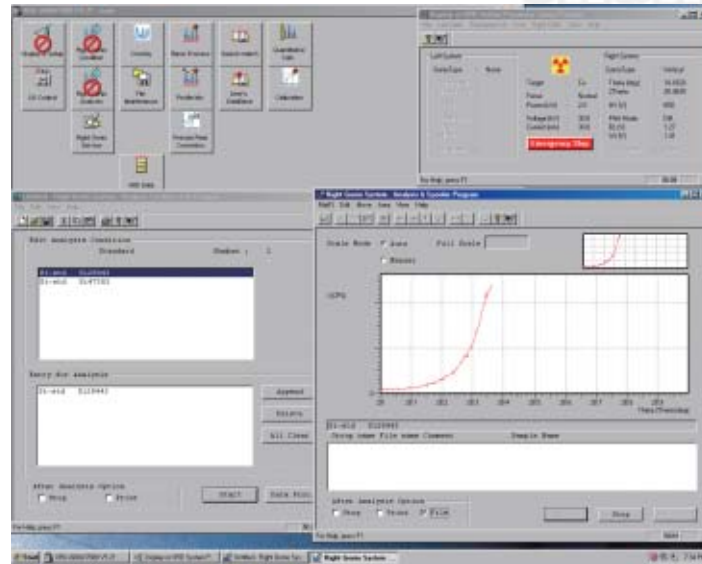
Auto search results and thin film sample overlay display

Automatic Measurement, Easy Operation

[Goniometer optical system adjustment and saving of adjustment data are both fully automated.]

Measurement Display

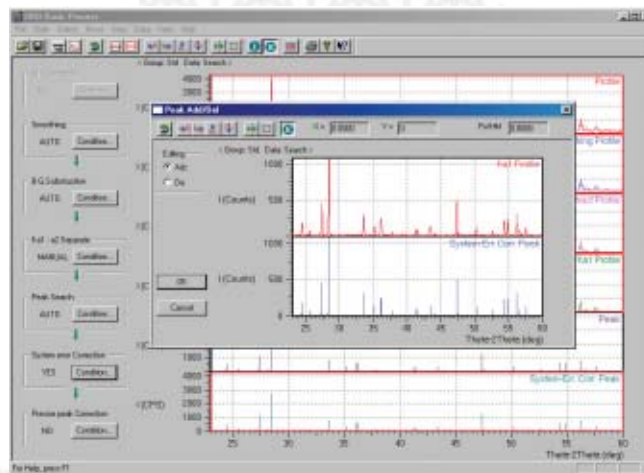
With the XRD-6000, sample measurement condition can be set by easy operation. The scheduling and the progress condition of the measurement can be confirmed at one view by the analysis spooler.



Multitasking for enhanced analysis efficiency

Basic Data Processing

The multitasking capability provided with the Windows XP operating environment allows measurement and data processing to be conducted simultaneously, enhancing the efficiency of analysis operations.

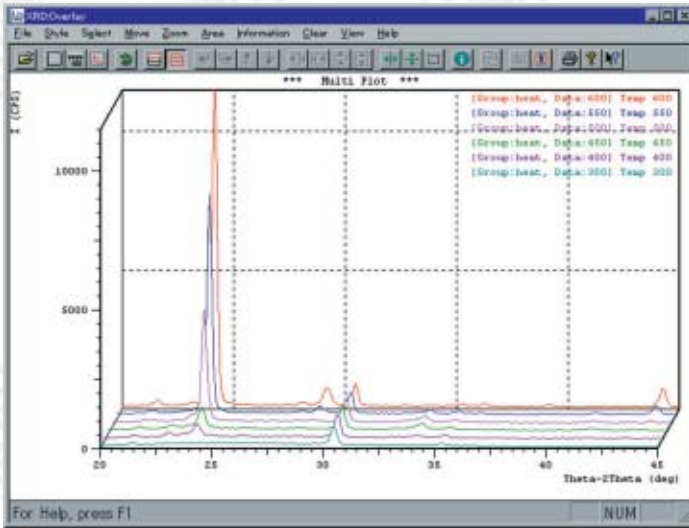


Basic Data Processing Screen

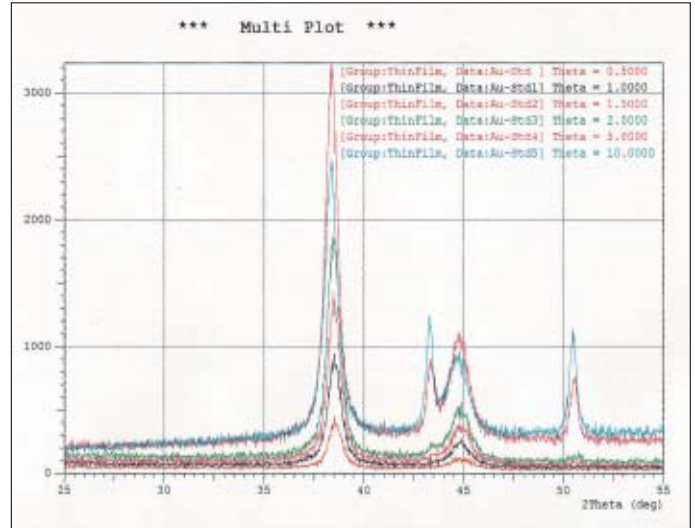
Pleasant Data Processing Environment

Graphic Display

Data can be freely zoomed with a click of the mouse, so profile comparison of thin film data or heating measurement data etc. is easily accomplished using combined 2-dimensional or 3-dimension-al display. The software also features a variety of other useful graphic functions, such as intensity Log conversion display and hidden-line processing on the 3-dimensional display, among others. Each type of data can be output to the color printer, so differences between samples can be recognized at a glance.



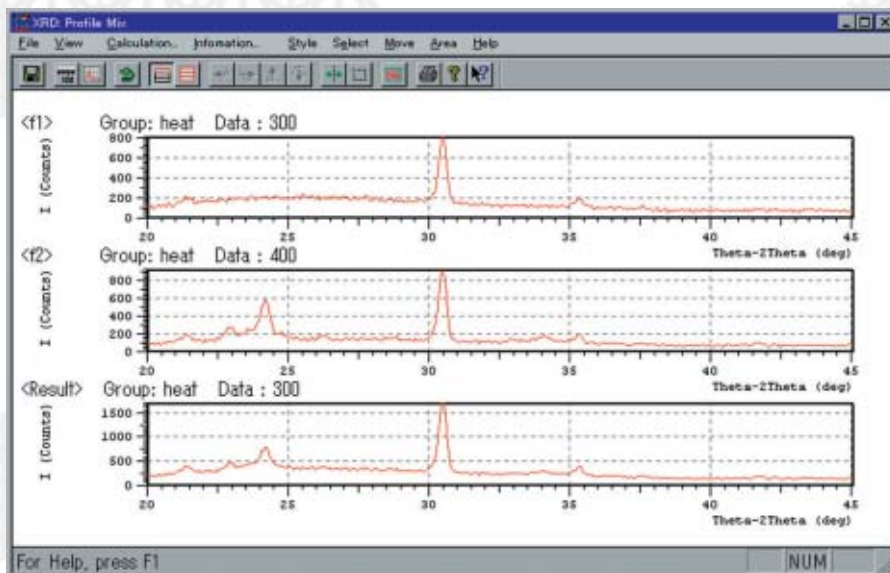
3-Dimensional Screen of Thin Film Sample



2-Dimensional Output of Thin Film Sample

Adding/Subtraction operations

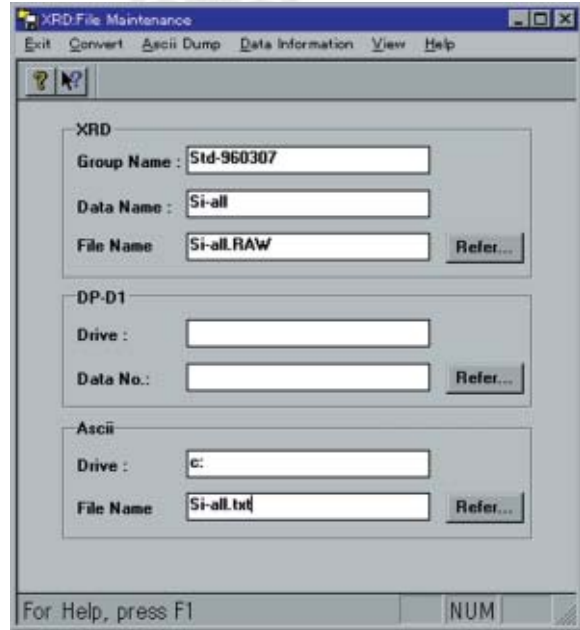
Data manipulation functions such as deletion of unnecessary peak profiles and addition of re-analyzed data to obtain a summed profile are some of the invaluable tools available for conducting efficient data analysis. Spectral calculations are conducted in the window displayed at right.



Spectral Calculation Window

File Maintenance ~Data Format Conversion~

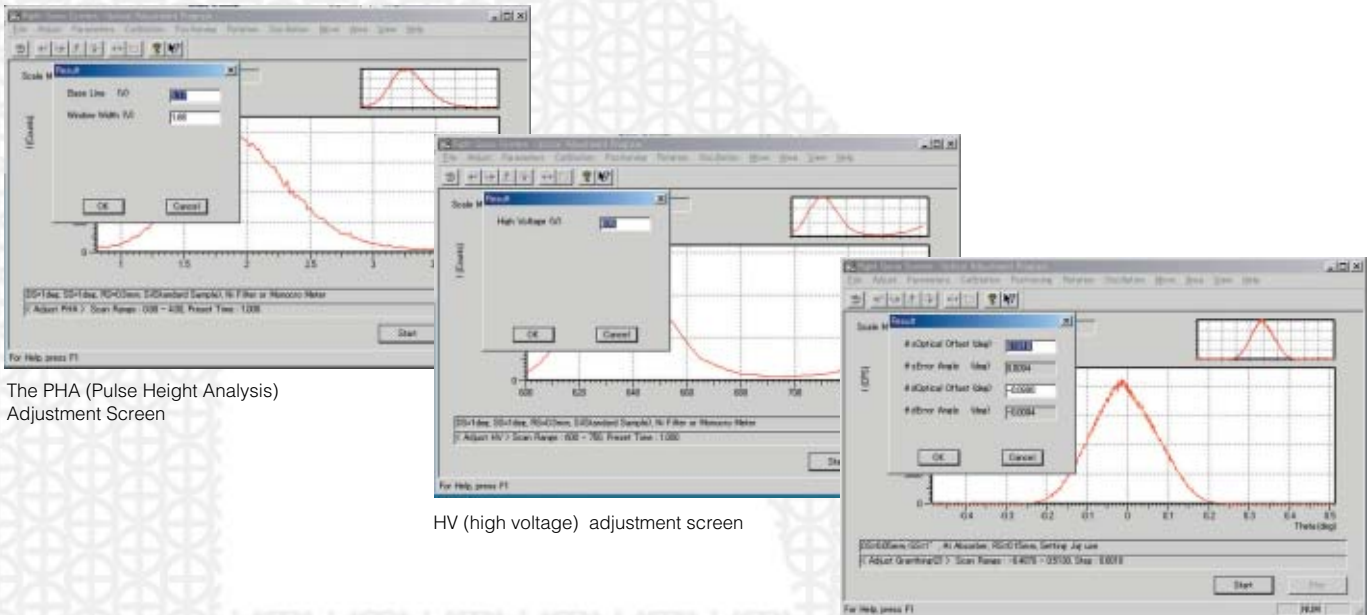
Conversion between profile data and text data, conversion from Shimadzu X-ray Diffractometer XD-D1 (previous model) acquisition data to XRD-6000 format data, and re-analysis are all possible. File format conversion is conducted using the window displayed at right.



File Conversion Window

Optical Adjustments

The XRD-6000 system makes fully automatic optical adjustments to the goniometer from the computer screen, even for optional attachments. In addition to completely automatically adjusting all settings, such as the zero angle for the θ and 2θ axes, the x-ray detector high voltage settings, the PHA baseline and window width settings, it also automatically saves the settings information. This feature can be utilized for routine maintenance.



The PHA (Pulse Height Analysis) Adjustment Screen

HV (high voltage) adjustment screen

θ -Axis Adjustment Screen

Enhanced Auto Search System

[Auto Search, General Quantitation Software Provided as Standard]

Identification work can be performed efficiently on screen.

Detailed search parameters can be set.

To obtain correct results with automatic search/match, search parameters that conform to each sample must be set. The XRD-6000 enables the setting of detailed search parameters such as selection of files to be used in the search and three levels of element data input. Furthermore, the XRD-6000 comes with a standard function for element data, which takes up qualitative results (element analysis) from X-ray fluorescence spectrometers as files via LAN.

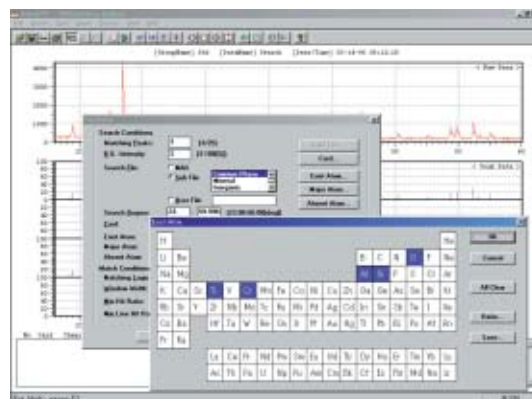
Replete with second search function for authoritative identification of small amount of components.

Identifying small amount of components with a primary search is difficult, a second search is needed after the major components have been identified. The XRD-6000 comes replete with a second search function to provide an environment for easy identification of small amount of components.

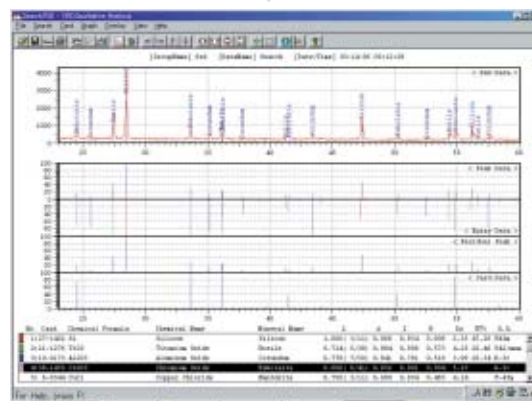
Various search result data can be displayed.

Search results can be stack-displayed with each standard data display over raw data. Also, for easy comparison, standard substance names, chemical equations, ore names, Miller indices, and ICDD numbers can be displayed on each peak. Furthermore, an easy quantitative calculation function using a corundum ratio for candidate substances is included in the equipment.

If your system has a PDF2 or PDF4 database, PDF2 or PDF4 detailed data for candidate substances can be displayed on a separate window.



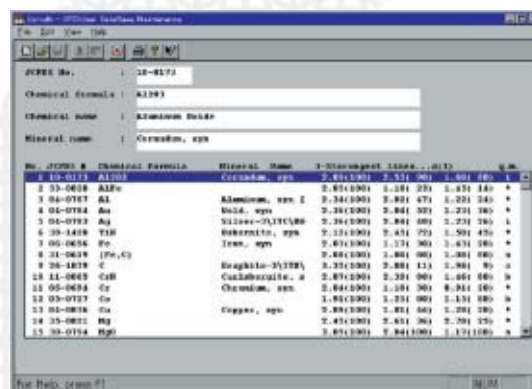
Search Parameter Setting Screen



Search Result Screen

Dedicated user database can be created.

The user's very own database file - separate from the sub-file supplied by ICDD (International Center for Diffraction Data) - can be created. Selected ICDD standard data and substance data not registered with ICDD can be input into this file. And data obtained through measurements by the XRD-6000 can be registered as they are in the database file, which means that the user's basic samples can be registered, and comparisons made with those substances to provide an extra dimension to quality control.



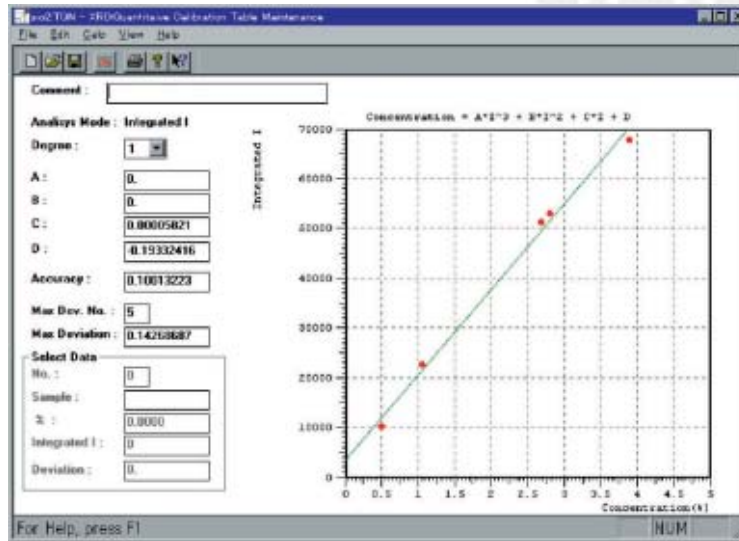
User Database Creation Screen

Polished Quantitation Software

[Satisfies your analysis objectives.]

Calibration Curves

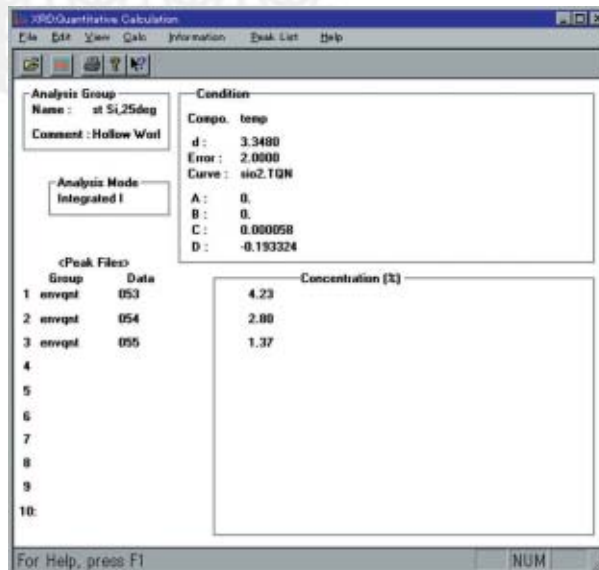
Calibration curves can be generated for intensity, integrated intensity or intensity ratio. Intensity and integrated intensity calculations are used for the internal standard and standard addition methods.



Calibration Curve Screen for Integrated Intensity

Quantitative Analysis

The internal standard method and 2 intensity methods are available to satisfy most of the application needs. Further, up to 5 peaks may be specified for quantitation and up to 10 sets of data may be calculated simultaneously.



Integrated Intensity Quantitation Results Screen

Note) Residual austenite quantitation and environmental quantitation software packages are optional.

Options

Qualitative analysis

Counter monochromator

Installed in the X-ray detector unit, the counter monochromator transforms X-rays which have passed through the entrance slit into monochromatic X-rays, allowing only the characteristic X-rays ($K\alpha$ rays) to be detected. Exclusion of all other X-rays from the sample, including continuous rays and $K\beta$ rays as well as fluorescent X-rays, ensures diffraction patterns with a high signal-to-noise ratio.

Part Description	Application	P/N
Counter monochromator CM-3121	Cu X-ray tube	215-22360-02
Counter monochromator CM-3131	Co X-ray tube	215-22360-03
Counter monochromator CM-3141	Fe X-ray tube	215-22360-04
Counter monochromator CM-3151	Cr X-ray tube	215-22360-05



ICDD PDF2 / PDF4

This is the powder X-ray diffraction database provided by ICDD. PDF2 is provided on CD-ROM, and contains, in addition to substance name, chemical formula and d-I data, miller indices, lattice constants, space groups and other crystallographic information. Using the special PDF2 Automatic Search Software (option), unknown substances may be easily identified via the registered crystallographic information.

ICDD PDF2	P/N for Educational institutions	P/N for Other uses
Single license ^{Note1)}	239-50002-12	239-50002-11

In addition to the functions of PDF2, database PDF4 has the functions of data searching software (DDVIEW+), the display of 2D, 3D structural chart, various lattice parameters, and the simulation wave form by the calculation, and the import of the measurement data. There are two kinds of databases of PDF4+ (for general) and PDF4/Organics (for organics).

ICDD PDF4+	P/N for Educational institutions	P/N for Other uses
Single license (New, 1years license)	239-50015-02	239-50015-01
Single license (Renewal, 1years license)	239-50015-04	239-50015-03
Single license (Renewal, 3years license)	239-50015-06	239-50015-05
Single license (Renewal, 5years license)	239-50015-08	239-50015-07

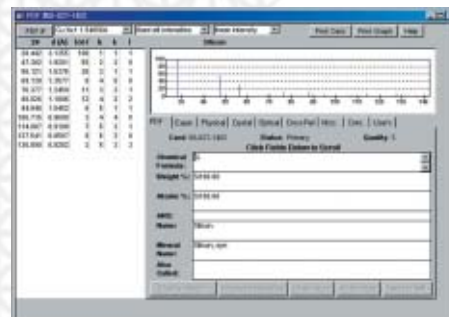
ICDD PDF4 / Organics	P/N for Educational institutions	P/N for Other uses
Single license (New, 1years license)	239-50015-22	239-50015-21
Single license (Renewal, 1years license)	239-50015-24	239-50015-23
Single license (Renewal, 3years license)	239-50015-26	239-50015-25
Single license (Renewal, 5years license)	239-50015-28	239-50015-27

PDF2 Search Software (P/N 215-00272)

Searches can be made from the card No., as well as searches on multiple elements using "AND" or "OR" conditions, with analyte identification and crystalline structure obtained simultaneously.

PDF2 Search Software (DDVIEW)	P/N for Educational institutions	P/N for Other uses
Single license ^{Note1)}	239-50002-22	239-50002-21

Note 1: After 5 years, this license will need to be re-affirmed in order to make it perpetual.



Quantitative Analysis

Rotational Sample Stage RS-1001

The RS-1001 performs in-plane rotation of the sample in combination with oscillation around the goniometer sample axis (θ) to minimize the scatter in diffraction pattern intensities attributable to the sample crystalline orientation, and thereby enhance the precision in most types of quantitative analysis.

Main specifications

- Rotation β axis (sample in-plane)
- Rotation speed 1~60rpm
- Minimum step width 0.1 degree
- Operation modes Constant speed rotation, oscillation sample in-plane rotation scan (continuous, step)
- Measuring angle range 2θ 7°~163°

Part Description	P/N
Rotational sample stage (with option driver)	215-21766
Rotational sample stage (without option driver)	215-21766-01



Environmental Measurement Stage RS-2001

A complete environmental analysis system, this comprises a special environmental quantitative analysis stage, filter holder and quantitation software. A special filter holder is provided which allows measurement using an asbestos-imbedded filter just as it is. The main specifications of the environmental stage are the same as those of the general purpose rotational sample stage. The calibration curve correction is based on Zn, however, when the diffraction line of the sample overlaps with that of Zn, an Al sample holder (optional) is also available. The sample stage option driver can also be used with the rotational sample stage.

Main specifications

Measuring angle range 2θ 7°~163°

Part Description	P/N
Environmental Analysis Stage (with option driver, S/W)	215-21767-02
Environmental Analysis Stage (with S/W)	215-21767-03
Al filter holder (ϕ 25)	215-22775-02
Aluminum sample holder (5PC)	215-22507-06
Aluminum sample holder (with through hole) (5PC)	215-22507-10



Options

Environmental Quantitation Software (P/N 215-00271-02)

Environment samples as suspended dust particles, in very small quantity, collected on filter present an analytical challenge. XRD-7000 allows a reliable analysis. The software eliminates the effect X-ray absorption by the filter, providing a calibration curve having good linearity and high accuracy. The software associated with the use of a special sample holder allows the application of a very efficient filter absorption correction.



Quantitation Results Screen

Automatic Analysis

Auto 5 Position Sample Changer (ASC-1001)

This stage is used in order to automatically measure maximum 5 samples. The ASC-1001 performs in-plane rotation of the sample in combination with oscillation around the goniometer sample axis (θ) to minimize the scatter in diffraction pattern intensities attributable to the sample crystalline orientation. Also it is possible to avail filter holder (option) for Environmental Measurement Stage RS-2001.

Main specifications

- Sample position 5
- Sample Size Powder: 25mm ϕ
Filter: 25mm or 47mm ϕ (option)
- Rotation speed 1~60rpm
- Measuring angle range 2θ 7°~163°

Part Description	P/N
Auto 5 position sample changer (with 2 option driver units)	215-23175
Auto 5 position sample changer (with a option driver unit)	215-23175-01
Zn filter holder (25mm ϕ)	215-22775-01
Al filter holder (25mm ϕ)	215-22775-02



Sample plates for RS-2001 and ASC

Part Description	P/N
Aluminum sample holder (5pc)	215-22507-06
Glass sample holder (5pc)	215-22507-07
Glass Micro sample holder (5pc)	215-22507-08
Non-reflective sample holder (2pc)	215-22507-09

Thin Film Analysis using Attachment THA-1101

This is a specialized thin film analysis system, including the thin film sample stage, monochromator and suction pump.

Employing the fixed incidence angle, parallel X-ray diffractometry method, penetration of incident X-rays into the substrate sample is limited as much as possible, providing low background, thin film X-ray diffraction patterns.

Specimens are easily set in place using the suction pump.

The sample stage option driver can also be used with the rotational sample stage.

Main specifications

- Rotation β axis (sample in-plane)
- Rotation speed 1~60rpm
- Minimum incidence angle 0.1degree
- Sample suction pump AC100V, 10W (1 pump)
- Operation modes Constant speed rotation, oscillation, sample in-plane rotation scan, (continuous, step)

Part Description	P/N
Thin film analysis attachment (with option driver)	215-21765
Thin film analysis attachment (without option driver)	215-21765-01



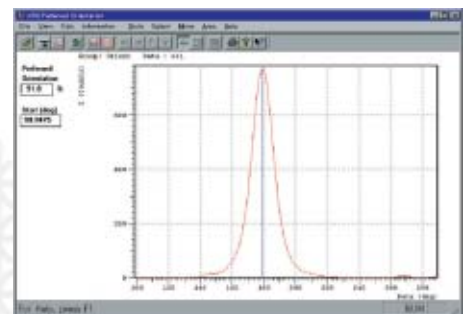
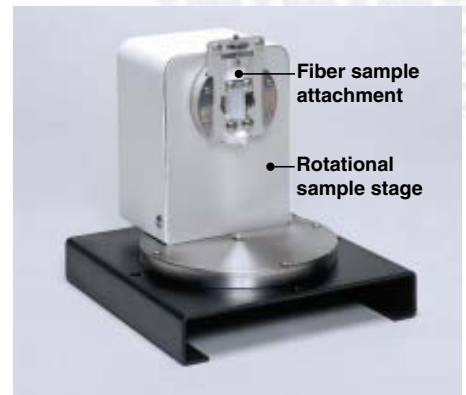
Fiber Sample Attachment

Used in combination with the Rotational Sample Stage (RS-1001), this system measures the degree of orientation for fibers. The acquired data is then processed using the provided fiber sample attachment software to calculate degree of orientation.

Part Description	P/N
Fiber sample attachment (with S/W)	215-22624

Fiber orientation software

- This software evaluates the degree of orientation for fiber samples, using the data of peak width at half height acquired from orientation measurement (sample in-plane β axis measurement).



Degree of Orientation Evaluation Screen

Options

AVS-1101 Automatic Variable Slit System

Environment samples as suspended dust particles, in very small quantity, collected on filter present an analytical challenge. XRD-7000 allows a reliable analysis. The software eliminates the effect X-ray absorption by the filter, providing a calibration curve having good linearity and high accuracy. The software associated with the use of a special sample holder allows the application of a very efficient filter absorption correction.

This mechanism automatically sets the DS, SS and RS slit widths according to the measurement mode selected on the screen.

- Fixed Irradiation Width Mode:
The emission slit is adjusted so that all sample surfaces are irradiated with the x-ray of the same width. The detector slits (SS and RS) are also adjusted in accordance with the irradiation width
- Fixed Irradiation Width Mode:
The DS, SS and RS slit widths are fixed at the set values.

The data obtained using this software can be converted to the conventional fixed-slit-width data by performing irradiation width compensation (patent pending).

Part Description	P/N
AVS-1101 Automatic Variable Slit System	215-23950



Degree of Orientation Evaluation Screen

MDA-1101/1201 Micro Area Measurement Attachment

The Micro Area Measurement Attachment uses a pinhole slit for emission, allowing the measurement of micro regions. Measured surfaces are observed via a CCD camera, so observation images can be loaded onto a computer, saved and edited. The product line includes two models: the MDA-1101 that uses an optical microscope and the MDA-1201 that uses a zoom (8 - 80 mm) camera lens.

Key Specifications

- Pinhole Emitter Slit 0.1, 0.2, 0.3, 0.5, 1, or 2 mm diameters
- XYZ Movement ± 7.5 mm
- Sample Surface Observation Method CCD camera image viewed on computer screen

Part Description	P/N
Micro Area Measurement Attachment (MDA-1101)	215-23180
Micro Area Measurement Attachment (MDA-1201)	215-23180-01



Stress Analysis Attachment SA-1101

This specialized stress analysis system using the side-inclination method include the stress analysis sample stand, X-ray tube and stress analysis software. X-ray stress analysis is widely used to measure the level of stress in substances. In the X-ray diffractometry of stress extremely small changes in the lattice space are measured from the X-ray diffraction pattern profile. The use of the special stress analysis stand associated with the side-inclination method allows the precise measurement of the residual stress. This technique is free of absorption error. The software includes following functions, as measurement, width at half height, peak position calculation and stress calculation. Depending the type of sample and reflective plane, either the Cr X-ray tube or Co tube is necessary. The sample stand option driver can also be used with the rotational sample stage.

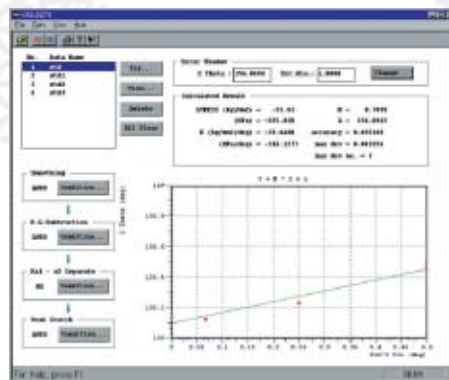
Main specifications

- Inclined axis α axis
- Inclined angle range 0-50 degrees
- Operation modes Oscillating, fixed

Part Description	P/N
Stress analysis attachment (with Cr tube, option driver, S/W)	215-21769
Stress analysis attachment (with Co tube, option driver, S/W)	215-21769-02
Stress analysis attachment (with Cr tube, S/W)	215-21769-01
Stress analysis attachment (with Co tube, S/W)	215-21769-03

Stress Analysis Software

- This software can analyze data obtained using either a parallel-beam (fixed ψ or fixed ψ_0) or orthogonal-beam method.



Residual Stress Analysis Result Screen

PCL-1001 Polycapillary Unit

The polycapillary unit is a new optical X-ray element that splits a single X-ray beam emitted from a point light source into multiple X-ray beams using three-dimensionally arranged capillary optics to create a powerful parallel beam output that covers a large area.

- 1) Compared to conventional methods, this unit uses the X-ray more effectively and increases the intensity of the diffracted X-ray, allowing more sensitive analysis.
- 2) With conventional methods, variations in sample surface height are directly translated into variations in X-ray diffraction angles. This polycapillary unit uses parallel beams, so it is not affected by variations in sample surfaces.

Part Description	P/N
PCL-1001 Polycapillary Unit	215-23980
CM-4121 Counter Monochromator Assembly (for parallel beams)	215-22360-06
X-Ray Tube (Long fine focus, with Cu target)	210-24100-11



Note: If an LFF type X-ray tube is used in the XRD-7000 system, the X-ray tube listed above is not required.

Options

Sample Heating Attachment HA-1001

This system, consisting of a special sample heating furnace and temperature controller, is used to heat the sample during X-ray diffractometry to study the influence of heat on the crystalline structure. The atmosphere in the furnace, consisting of air, an inert gas or a vacuum, may be heated to 1500°C during measurement. The measurement results are output in multiple data format to enable comparison of X-ray diffraction patterns obtained at various temperatures.

Main Specifications

- Thermocouple Pt-Pt/Rh
- Measurement temperature 1500°C max. in vacuum, air
1200°C max. using inert gas (N₂)
- Control functions PID value setting, fixed temperature control
(temperature increase, decrease, hold, stop)
- Power supply Single phase 200/220V±10% 10A

Part Description	P/N
Sample heating attachment (with temperature controller)	215-23000



HA-1001

Heating or cooling attachment TTK-450

This system, consisting of a special sample heating furnace and temperature controller, is used to heat the sample during X-ray diffractometry to study the influence of heat on the crystal structure. The atmosphere in the furnace, consisting of air, an inert gas or vacuum, may be heated to 450°C during measurement at TTK-450.

With vacuum kit and cooling kit, the atmosphere may be cooled to -180°C at TTK-450.

The measurement results are output in multiple data format to enable comparison of X-ray diffraction patterns obtained at various temperature.

Main Specifications

	TTK-450
Thermocouple	PT100 resistor
Power supply	RT~300°C (in the air, or an inert gas)
Temperature	RT~450°C (in vacuum) -180~450°C (With cooling kit in vacuum)
Control functions	PID value setting fixed temperature control (increase, decrease, hold, stop)
Power supply	single phase 200/220V±10% 5A

Part name	P/N
Heating attachment TTK-450	215-24030-91
Vacuum kit for TTK-450	215-24034-92
Cooling kit for TTK-450	215-24033-92

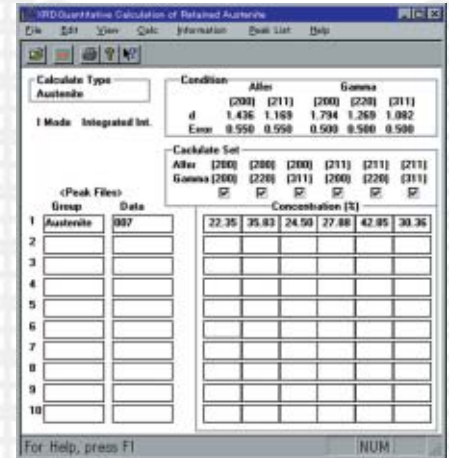


TTK-450

Quantitative Analysis

Residual Austenite Quantitation (P/N 215-00270-02)

Common method to quantify the residual austenite is to apply the method for samples consisting of 2 components such as tempered copper α -iron and γ -iron. The special software allows the determination without the need of standard sample. The software directly uses the intensity ratio of the measured X-ray peaks of the α -iron and γ -iron components to theoretically perform the calculation. The five-peak average method is used to make the determination, so scattering due to the matrix effect is reduced to enhance the reliability of the results. Using the rotational sample stage (P/N 215-21766) for measurement even further helps to overcome data scattering.

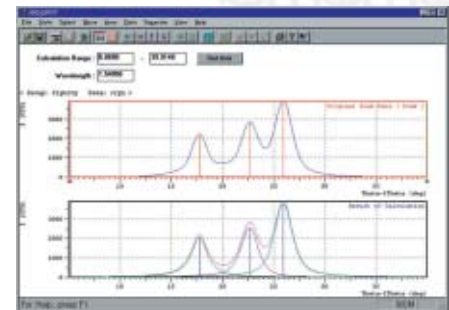


Quantitation Results Screen

Peak Processing

Overlapping Peak Separation Software (P/N 215-00273-02)

Using the Gauss and Lorentz models, overlapping peaks are separated one by one, with information including position, intensity, width at half height and integrated intensity calculated for each diffraction peak. These are then utilized to conduct quantitative analysis and crystalline structure analysis.

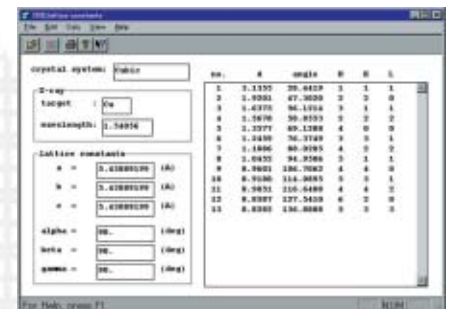


Peak Separation Screen

Crystalline Structural Analysis

Precise lattice constant determination software (P/N 215-00274-02)

In X-ray diffractometry, a higher accuracy is often required to determine the lattice constant, which is a fundamental parameter for determining a substance's crystalline structure. This is most often used for quantitating solid solution content. This software corrects the raw diffraction angle data calculated via basic data processing to determine enhanced precision lattice constants for up to 7 crystals concurrently, employing the least squares method to even further minimize error in diffraction angles. In addition, the miller index is applied to each peak.



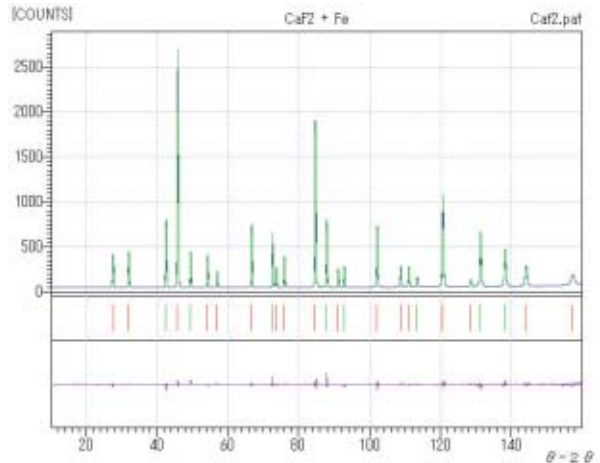
Precise lattice constant determination calculation Result Screen

Options

Rietveld Analysis Software (P/N 215-00283-02)

The Rietveld method analyzes the crystalline structure by directly refining structural parameters and lattice constants over the entire powder X-ray or neutron diffraction pattern. It compares the diffraction pattern calculated from a presumed structural model with the actually measured pattern, and refines each parameter using the nonlinear least square method developed by the National Institute for Materials Science (formerly the Institute for Research in Inorganic Materials). This Rietveld Analysis Software utilizes the RIETAN program created by Mr. Fujio Izumi at the National Institute for Materials Science.

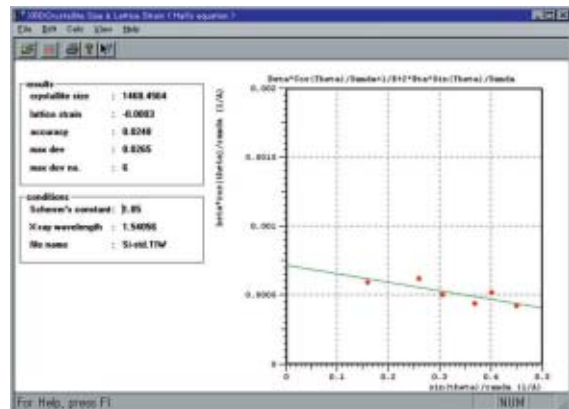
Part Description	P/N
Rietveld analysis software RIETAN	215-00283-02



State Analysis

Crystallite Size & Lattice Strain Software (P/N 215-00276-02)

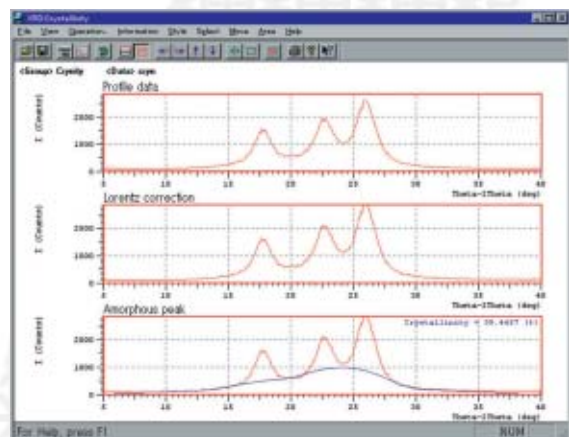
Samples normally consist of crystallites ranging in size from several μm to tens of μm . However, in the case of catalyst crystallites, which may measure several hundred \AA , X-ray diffraction is insufficient, resulting in diffraction peak spreading. This software quantitatively determines that spread, and applies that Scherrer's equation to calculate the crystallite size. When there is involvement of lattice strain, the diffraction spread is determined for a number of diffraction peaks, and from the resultant line slope and intercepts, the size of each of the crystallites and the lattice strain are calculated. (Hall's Method)



Hall's Equation Calculation Result Screen

Crystallinity Calculation Software (P/N 215-00277-02)

The degree of crystallization of a mixture of crystalline and amorphous substance, such as found in high polymer samples, is an important parameter of substance characterization. This software automatically or manually separate the measured diffraction patterns into those of crystalline components and those of amorphous components. Then, it calculate the integrated intensity of the two types of substance, called degree of crystallization using the peak area ratio of the two classes of components.

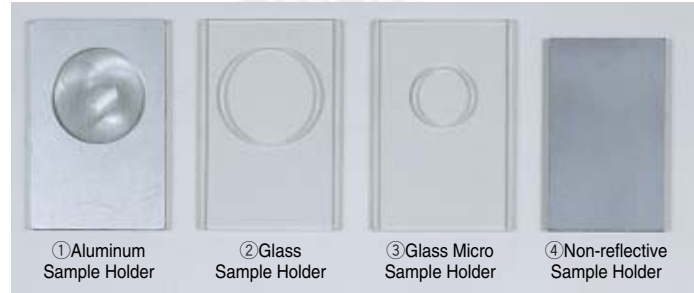


Crystallinity Calculation Result Screen

Other Options

Sample Holders

The following sample holders are available to allow different application, including the aluminum sample holder,



Part Description	Sample area	Application	Remarks	P/N
Aluminum Sample Holder	ø25 (dia.) x 1mm (d)	General purpose	Made of aluminum, 5pc	215-22507-01
Glass Sample Holder	ø25 (dia.) x 1mm (d)	Lattice constant	Made of glass, 5pc	215-22507-02
Glass Micro Sample Holder	ø15 (dia.) x 0.5mm (d)	Micro samples	Made of glass, 5pc	215-22507-03
Non-reflective Sample Holder		Ultramicro samples	Made of silicon, 2pc	215-22507-05

X-ray Tubes and X-ray Filters

Focus Type	Type NF	Type BF	Type LFF	X-Ray Filter
Focus Size Tube voltage, current	1 x 10mm 60kV, 50mA	2 x 12mm 60kV, 60mA	0.4 x 12mm 60kV, 55mA	
Target	X-ray Tube Maximum Load & P/N			Part Description P/N
Cu	2.0kW (062-40003-03)	2.7kW (210-24016-21)	2.2kW (210-24100-11)	Ni filter (for Cu) (215-22500-02)
Co	1.8kW (062-40003-04)	2.7kW (210-24016-24)	1.8kW (210-24100-14)	Fe filter (for Co) (215-22500-03)
Fe	1.5kW (062-40003-05)	2.7kW (210-24016-25)	1.0kW (210-24100-15)	Mn filter (for Fe) (215-22500-04)
Cr	1.8kW (062-40003-06)	2.7kW (210-24016-26)	1.9kW (210-24100-16)	V filter (for Cr) (215-22500-05)

Cooling Water Circulator

HYCOOL HYW2023C-S15
(for 2kW X-ray tube)

HYCOOL HYW2045C-S36
(for 3kW X-ray tube)

With its built-in cooler, the Cooling Water Circulator cools the X-ray tube and X-ray generator by circulating cooled, pure or clean water. The unit is recommended when no tap water is available or the available water is of poor quality.



Main specifications

- Power supply Single phase 200V ±10% 20A (HYW2023C-S15)
Single phase 200V ±10% 30A (HYW2045C-S36)
- Ambient temperature 5~40°C
- Cooling capacity 1750/2000kcal/h (50/60Hz) (HYW2023C-S15)
3600/3900kcal/h (50/60Hz) (HYW2045C-S36)

Part Description	P/N
HYCOOL HYW2023C-S15	044-01807-11
HYCOOL HYW2045C-S36	044-01807-12

Cooling Water Pump CW-1

This water pump supplies cooling water to the X-ray tube and high voltage tank.

It is recommended when the available tap water has a pressure below 3kgf/cm² or when the water pressure fluctuates excessively.

Main specifications

- Power supply AC 100/200V 5/2.5A
- Output pressure 0~5kgf/cm²(continuously variable)

Part Description	P/N
Cooling water pump CW-1	239-15023



System Configuration and Accessories

Following is the standard system configuration and the various accessories listed according to application.

1 Standard configuration

	2kW type	3kW type
XRD-6000	1 unit P/N 215-21750-10	1 unit P/N 215-21750-12

- Goniometer 1
- Data processor 1
- High voltage transformer
- X-ray tube 1
- Scintillation detector 1
- Standard accessories 1set

2 Special setup accessories

- Tap water pressure low
Cooling water pump CW-1 P/N 239-15023
- Un-available tap water or low quality tap water
Cooling water circulator HYCOOL HYW2023C-S15 P/N 044-01807-11
Cooling water circulator HYCOOL HYW2045C-S36 P/N 044-01807-12

3 Convenient sample holders

- Glass Sample Holder $\phi 25 \times 1.0$ 5pc/set P/N 215-22507-02
- Glass Micro Sample Holder $\phi 15 \times 0.5$ 5pc/set P/N 215-22507-03
- Non-reflective Sample Holder 2pc/set P/N 215-22507-05

*For application, refer to information on Sample Holders

4 Main maintenance / consumable items

- X-ray tube 2.0kW, NF P/N 062-40003-03
- X-ray tube 2.7kW, BF P/N 210-24016-21
- Si standard sample, 20g 325 mesh 1 P/N 215-21723

Special Accessories

◎: Absolutely required ○: Required ●: Required depending on objective

Analysis Objective	Part Description	Part Number	Iron and steel related	Non-ferrous metals, precious metals	Machinery, automotive shipbuilding, welding	Brickmaking, ceramics	Cement and glass	Electrical, electronic materials	Foodstuffs, textiles, paper, pulp	Chemicals, catalysts, dyes, paints	Medical, dental materials, biological organisms	Natural resources, energy	Construction, engineering	Environment, industrial waste
			◎	○	○	○	○	○	○	○	○	○	○	○
1 BG reduction, especially iron samples	Counter Monochromator CM-3121	P/N 215-22360-02	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
2 Qualitative analysis PDF2 Search	ICDD PDF2 file (CD-ROM)	P/N 239-50002-11,12	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	PDF2 Search S/W (DDVIEW)	P/N 239-50002-21,22												
3 Qualitative analysis PDF4 Search	ICDD PDF4 + (CD-ROM)	P/N 239-50015-01,02	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
4 General purpose quantitative analysis	Rotational Sample Stage RS-1001	P/N 215-21766	○	○	○	○	○	○	○	○	○	○	○	○
	Auto 5 position sample changer ASC-1001	P/N 215-23175												
5 Residual austenite quantitation	Residual austenite quantitation S/W	P/N 215-00270-02	○		○									
	Rotational Sample Stage RS-1001	P/N 215-21766	○		○									
6 Environmental quantitative analysis system	Environmental Quantitative Analysis Stage RS-2001 (Filter holders Zn, with S/W)	P/N 215-21767												◎
	Filter holder Al (ϕ 25mm)	P/N 215-22775-02												◎
7 Multiple peak separation	Peak separation S/W	P/N 215-00273-02	●	●	●	●	●	●	●	●	●	●	●	●
8 Precise lattice constant determination	Precise lattice constant determination S/W	P/N 215-00274-02	●	●	●	●	●	●		●				
9 Crystal structure analysis	Rietveld analysis, Software RIETAN	P/N 215-00283-02	●	●	●	●	●			●				
10 Crystallite size / lattice stress	Crystallite Size / Lattice Stress S/W	P/N 215-00276-02							○	○	○			
11 Degree of crystallization	Degree of Crystallization S/W	P/N 215-00277-02	●						○	○	○			
12 Heating analysis	Sample Heating Attachment HA-1001	P/N 215-23000-01	●	●	●	●	●	●		●	●			
13 Thin film analysis	Thin Film Analysis Attachment THA-1101 (stage, monochromator, suction pump)	P/N 215-21765	●	●	●	●	●	●						
14 Fiber degree of orientation analysis	Rotational Sample Stage RS-1001*	P/N 215-21766	●	●	●	●	●	●	○	●				
	Fiber Sample Attachment (with S/W)	P/N 215-22624	●					●	○	●				
15 Residual stress analysis	Stress Analysis Attachment SA-1101 (with Cr X-ray tube, S/W)	P/N 215-21769	○	○	○	●	●							
16 Micro Measurement	Micro-Measuring Attachment MDA-1101	P/N 215-23180	●	●	●	●	●				●			
17 Fixed irradiation width analysis	Automatic Variable Slit System AVS-1101	P/N 215-23950	●	●	●	●	●	●	●	●	●	●	●	●
18 Powerful parallel X-ray beam / Bumpy samples	Polycapillary Unit PCL-1001	P/N 215-23980	●	●	●	●	●	●	●	●	●	●	●	●

*Can be used together with general purpose rotational sample stage

Main Specifications

XRD-6000

Item		XRD-6000 2kW type	XRD-6000 3kW Type
X-ray tube	Type	Cu, NF type	Cu, BF type
	Focus	1.0 x 10mm	2.0 x 12mm
	Max. output	2kW	2.7kW
X-ray generator	Max. output	3kW	
	Output stability	±0.01% (for 10% power fluctuations)	
	Max. tube voltage	60kV	
	Max. tube current	80mA	
	Voltage step width	1kV	
	Current step width	1mA	
	Overload limit setting	Setting changeable with tube type	
	X-ray tube protection	Against undervoltage, overload, overvoltage, overcurrent and/or failure of water supply	
	Safety mechanisms	Door interlock mechanism (X-ray can be generated only after door is closed) Emergency stop	
Goniometer	Type	Vertical typ	
	Scanning radius	185mm	
	Min. step angle	0.002°(2θ) 0.001°(θ)	
	Angle reproducibility	±0.001° (2θ)	
	Scanning angle range	-6°~163° (2θ), -180°~180°(θ)	
	Scanning system	θ/2θ linkage mode, θ, 2θ independent mode	
	Operation mode	Continuous scan measurement, step scan measurement, calibration, positioning, θ axis oscillation (when using 2θ continuous scan or step scan)	
	Slewing speed	1000°/minute (2θ)	
	Scanning speed	0.1°~50°/min (2θ), 0.05°~25°/min (θ)	
	Divergence slit (DS)	0.5°, 1°, 2°, 0.05mm	
	Scattering (SS)	0.5°, 1°, 2°	
	Receiving slit (RS)	0.15mm, 0.3mm	
	Detector/counter	Detector	Scintillation counter
Scintillator		Na I	
Scaler		Preset time 0.1 ~ 1000 sec No. of columns 7 columns	
HV/PHA		High voltage supply 500 - 1200V, baseline and window auto-control	
Casing	Dimensions	W900 x D700 x H1600	
	Leakage X-rays	Less than 2.5μSv/h (at maximum output)	

Data Processing Unit

Computer type	IBM PC/AT compatible
OS	WindowsXP
Display	17-inch color monitor
Printer	Color printer (A4)
Items controlled	Goniometer, X-ray generation, tube voltage, tube current, detector high voltage, PHA, scaler
Basic data processing	Smoothing, BG elimination, Kα1-Kα2 separation, peak searching, peak width at half height, integrated intensity, systematic error correction, internal/external standard correction, operations between data, graphic display
Qualitative analysis	database (library) creation, automatic library search (ICDD PDF2/PDF4 options) calibration curve generation, quantitation calculation
Quantitative analysis	Calibration curve generation, quantitative analysis

*Windows is a registered trademark of Microsoft Corporation



WARNING

X-RADIATION

Do not release interlocks, and do not remove panels and windows to avoid the risk of exposure to X-radiation.



CAUTION

RISK OF ELECTRIC SHOCK

DO NOT open this cover.

Installation Requirements

Installation Site

This instrument uses X-rays for measurement and analysis. Accordingly, before installing the instrument, be sure to consult local regulations regarding measures associated with X-ray generation, and comply with all necessary regulatory procedures.

Power requirements

For main unit	Single phase 200/220V ±10% 2kW type: 30A 3kW type: 50A
Data processing unit	Single phase 100V ±10% 10A
Ground	Independent, at least 100 Ω resistance

Installation site environment

The following ambient temperature and humidity are required.

Temperature	23°C ± 5°C
Humidity	60% ± 5%

Heat generated from the instrument is approximately 860cal/h. When the cooling water circulator is installed in the same room, this is increased by 2,720cal/h and 4,580cal/h for the 2kW and 3kW types, respectively.

Cooling water supplied to instrument

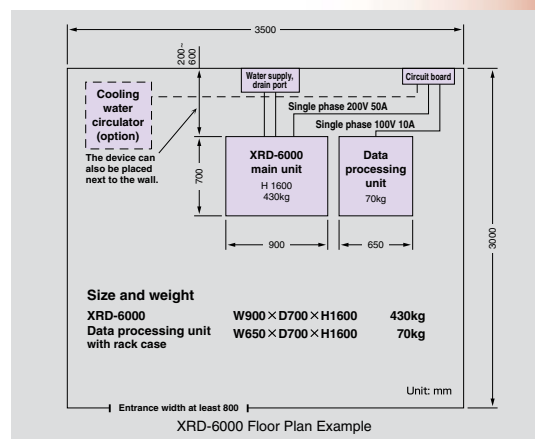
When cooling water supplied to the instrument becomes dirty due to piping corrosion, etc., this causes clogging of the X-ray tube filters. Cooling water should be supplied using the following conditions.

Temperature	23°C ± 5°C
Humidity	60% ± 5%

Avoid any sudden changes in temperature, which might cause condensation to form on the surfaces of internal parts. Heat generated from the instrument is approximately 860cal/h. When the cooling water circulator is installed in the same room, this is increased by 2,720cal/h for the 2kW X-ray tube and 4,580cal/h for the 3kW X-ray tube.

Flow rate	at least 4.0L/min
Water pressure	3~5kgf/cm²
Water quality	pH6-8, hardness less than 80ppm
Particulates	less than 0.1mm
Supply water port diameter	12.7mmφ
Drain water port	Natural drainage

If the flow rate is lower than 4.0L/min, the safety circuit for protection of the X-ray tube is active, disabling the X-ray generation circuit. When minimum conditions of flow-rate could not be fulfilled, use the cooling water circulator, available as an option.



JQA-0376

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