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## Product Information

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# SMALL & WIDE ANGLE X-RAY DIFFRACTOMETER

## 1 . Introduction

A newly developed X-ray diffractometer was designed to measure X-Ray diffraction patterns of polymeric materials, inorganic materials and other diverse substances in both small and wide angle regions by utilizing different detectors. This new system permits the selective use of detectors such as the SC (zero dimensional detector), the PSPC (one dimensional detector) and the IP (two dimensional detector). Small angle X-ray scattering, preferred orientation and crystallinity measurements are available evaluation methods of polymeric materials. Information that can be obtained from small angle scattering measurement ( $2\theta =$  below several degrees), which is not affected by the material condition, includes particle size (or void diameter), long periodicity structure (period of the electron density gradation) and reflectivity (interface roughness and layers' thickness). Other information obtainable from preferred orientation and crystallinity includes the orderliness of the crystal arrangement (preferred orientation) and the ratio of the crystalline properties to the noncrystalline properties (crystallinity). Further information obtainable from the measurement of thin film, pole figure and powder patterns (wide angle regions) regarding inorganic materials is crystallization of matter. From this information, one can evaluate the mechanical strength of material, its composition and mixtures, etc.

To evaluate the properties of mater, it is necessary to evaluate them from every possible angle including small angle scattering measurement as well as measurement in wide angle regions. To date, no equipment has been capable of permitting a variety of measurements with a single unit. This small & wide angle X-ray diffractometer which has been newly developed is the first of its kind.



## 2. Features

(1) Various optical systems are available for selective use.

### *1 Small angle optics*

- The 3-slit optics and the Kratky U slit optics are easily interchangeable through an exchange of the slit system as a unit. The use of the Kratky U slit makes it possible to measure the resolution in a smaller angle region up to  $2\theta=0.02^\circ$  to  $0.032^\circ$  ( $4200 \text{ \AA}$  to  $2760 \text{ \AA}$  with  $\text{Cu K}\alpha$ ).
- For the 3-slit optics, both the line and point foci are available as standard.

When the measurement intensity is weak or when high resolution is required in small angle areas, the line focus optics is suitable. On the other hand, when a two-dimensional scatter pattern is to be measured or when the small angle resolution is below  $400 \text{ \AA}$  with  $\text{Cu K}\alpha$ , then the point focus optics which does not need slit correction can be used appropriately.

- An incident beam monochromator and a diffracted beam monochromator are available.

With the monochromator, one can get monochromatic X-rays comprising  $K\alpha$  radiation alone which is characterized by high parallelism. This radiation is effective for the measurement of particle size, reflection small angle and reflectivity.

- The zero dimensional detector SC (scintillation counter), the one dimensional detector PSPC (position sensitive counter) and the two dimensional detector IP (imaging plate) can be used selectively according to the need. In the case of using either the PSPC or IP, the camera length can be extended to 500 mm, maximum, with the aid of an extension bench.

## II Wide angle optics

- A parallel beam wide angle optical system with line and point foci can be implemented simply by using the 3-slit optics. This optical arrangement is applicable for the measurement of thin film (line focus optics), crystallinity, preferred orientation, pole figure (point focus optics), etc.
- By exchanging each incident slit and receiving slit as a unit in a manner similar to the automatic exchange slit, fully automated measurement can be made based on the focusing optical system. Also, by using the 2nd slit and receiving slit of the 3-slit optics, one can conduct measurement based on the focusing optical system. In either case the goniometer radius is 285mm. This optical arrangement is applicable for the measurement of powder diffraction patterns, etc.

(2) Diverse measurements and analyses can be performed just by replacing slits.

### I Measurement methods with 3-slit optics (parallel beam)

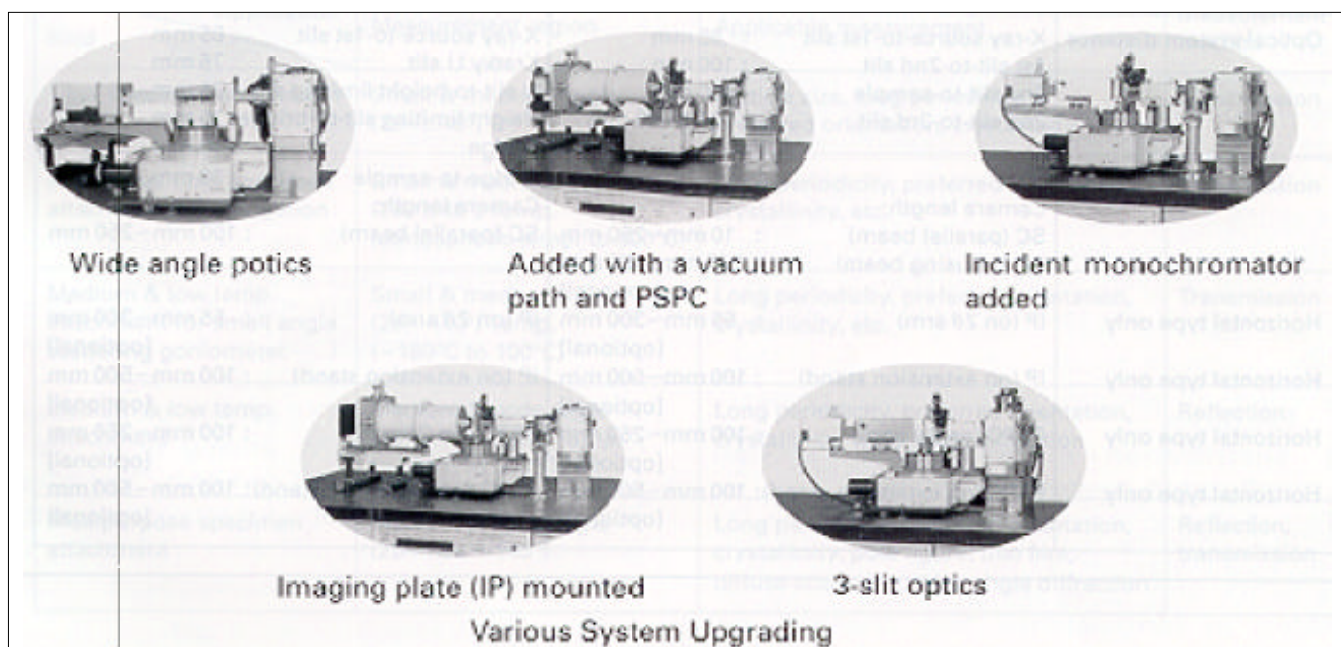
- Particle size, long periodicity, reflection, small angle (small angle region):  
Use line slit or pinhole slits for the 1<sup>st</sup> and 2<sup>nd</sup> slit.
- Crystallinity, preferred orientation (medium angle and wide angle regions):  
Use pinhole slits for the 1st and 2nd slit.
- Pole figure (wide angle region):  
Use pinhole slits for the 1st and 2nd slit.  
Or use a vertically or horizontally rectangular slit for the 2nd slit.
- Thin film (wide angle region):  
Use line slits for the 1st and 2nd slit.

### II Measurement methods with the wide angle optics (focusing beam)

- Measurement of powder patterns (wide angle region):  
Use the incident slit and receiving slit to serve as the automatic exchange slits. Or use the 2nd slit of the 3-slit optics.

(3) The optical axis is easily adjustable.

A zero axis (sample axis) adjuster is adapted, in order that the optical axis adjustment be made more easily than with the existing small angle scattering goniometer from Rigaku.



### 3. Specifications

	Horizontal/vertical type small & wide angle diffractometer	Horizontal type Kratky small & wide angle diffractometer	
Driving range	$\theta$ angle $0^{\circ}\sim 360^{\circ}$	$\theta$ angle $0^{\circ}\sim 360^{\circ}$	
(minimum step angle = $0.001^{\circ}$ )	$2\theta$ angle (horizontal) $-60^{\circ}\sim 145^{\circ}$	$2\theta$ angle $-60^{\circ}\sim 145^{\circ}$	
	$2\theta$ angle (vertical) $-10^{\circ}\sim 145^{\circ}$		
Incident beam monochromator*	Flat graphite crystal (horizontal type only. Unavailable for vertical type)	Flat graphite crystal	
Incident slit	1st, 2nd pinhole: $\phi 0.15$ mm, $\phi 0.2$ mm, $\phi 0.3$ mm, $\phi 0.4$ mm, $\phi 0.5$ mm, $\phi 0.6$ mm	Incident slit: 10 $\mu$ m, 30 $\mu$ m, 70 $\mu$ m	
	1st, 2nd slit: 0.03 mm, 0.04 mm, 0.05 mm, 0.06 mm, 0.08 mm, 0.1 mm		
	Height limiting slit: 12 mm, 15 mm	Height limiting slit: 0~30 mm (continuously variable)	
	3rd slit: Vertically: 0~20 mm variable Horizontally: 0~6 mm variable (Motor -driven type: Optional)		
Receiving slit	Receiving slit (RS): 0.05 mm, 0.1 mm, 0.2 mm	Receiving slit (RS): 0.02 mm, 0.14 mm	
	Scatter slit (SS): 0.25 mm, 0.4 mm	Scatter slit (SS): 0.1 mm, 0.3 mm	
	Height limiting slit: 0.5 mm, 2 mm, 10 mm	Height limiting slit: 6 mm, 8 mm, 10 mm, 15 mm, 0.2 mm	
		Vertical scatter preventive slit: S6 mm, S8 mm, S10 mm	
Optical system distance	X-ray source to 1st slit: 85 mm	X-ray source to 1st slit: 85 mm	
	1st slit to 2nd slit: 100 mm	Kratky U slit: 75 mm	
	2nd slit to sample: 100 mm	U slit to height limiting slit: 35 mm	
	2nd slit to 3rd slit: 24.5~80 mm	Height limiting slit to bridge: 35 mm	
	Camera length:	Bridge: 30 mm	
	SC (parallel beam): 10 mm~250 mm	Bridge to sample: 30 mm	
	SC (focusing beam): 250 mm, 185 mm*	Camera length:	
		SC (parallel beam): 100 mm~250 mm	
	Horizontal type only	IP ( on $2\theta$ arm): 55 mm~300 mm*	IP ( on $2\theta$ arm): 55 mm~300 mm*
	Horizontal type only	IP (on extension stand): 100 mm~500 mm*	IP (on extension stand): 100 mm~500 mm*
Horizontal type only	PSPC ( on $2\theta$ arm): 100 mm~250 mm*	PSPC ( on $2\theta$ arm): 100 mm~250 mm*	
Horizontal type only	PSPC (on extension stand): 100 mm~500 mm*	PSPC (on extension stand): 100 mm~500 mm*	

\* optional

## 4. Optional Items

### (1) Slit system for focusing optics (optional)

Slit dedicated to wide angle goniometer (D/max series automatic exchange slit)	3-slit optics for small angle goniometer
Incident slit (DS): In case of 285 mm goniometer radius $\frac{1}{4}^\circ$ , $\frac{1}{2}^\circ$ , $1^\circ$ , 0.05 mm (automatic exchange)	Incident slit (DS): In case of using 2nd slit 0.8 mm ( $\frac{1}{4}^\circ$ ), 1.6 mm ( $\frac{1}{2}^\circ$ ), 3.2 mm ( $1^\circ$ ) (manual insertion)
Scatter slit (SS): $\frac{1}{4}^\circ$ , $\frac{1}{2}^\circ$ , $1^\circ$ , $2^\circ$ (automatic exchange)	Scatter slit (SS): 0.2 mm, 0.4 mm, 0.8 mm (manual insertion)
Receiving slit (RS): 0.15 mm, 0.3 mm, 0.6 mm (automatic exchange)	Receiving slit (RS): 0.08 mm, 0.15 mm, 0.3 mm (manual insertion)

### (2) Major attachments (optional)

#### 1) Combination of attachment and optics

Attachment	Optics	
	Wide angle optics	3-slit optics
Fiber specimen attachment	◇	◇
High temp. Specimen attachment for elongation		◇
Medium & low temp. attachment for small angle goniometer		◇
Medium & low temp. attachment	◇	
Multipurpose specimen attachment	◇	◇

Note: a usable optic is indicated by ◇ mark.

#### 2) Specifications of attachments

Kind	Application	Measurement region	Applicable measurement	Measurement method
Fiber specimen attachment		Small & medium angle ( $2\theta = \pm 40^\circ$ )	Particle size, long periodicity, preferred orientation, crystallinity	Transmission
High temp. Fiber specimen attachment for elongation		Small & medium angle ( $2\theta = \pm 40^\circ$ ) Temp. (Atmospheric temp. to $300^\circ\text{C}$ )	Long periodicity, preferred orientation, crystallinity, etc.	Transmission
Medium & low temp. attachment for small angle scattering goniometer		Small & medium angle ( $2\theta = -40^\circ$ ) Temp. ( $-180^\circ\text{C}$ to $100^\circ\text{C}$ )	Long periodicity, preferred orientation, crystallinity, etc.	Transmission
Medium & low temp. attachment		Medium & wide angle ( $2\theta = -10^\circ \sim 145^\circ$ ) Temp. ( $-160^\circ$ to $300^\circ\text{C}$ )	Long periodicity, preferred orientation, crystallinity, wide angle diffraction	Reflection
Multipurpose specimen attachment		Medium & wide angle ( $2\theta = -90^\circ \sim 145^\circ$ )	Long periodicity, preferred orientation, crystallinity, pole figure, thin film, diffuse scattering, wide angle diffraction	Reflection, transmission