X-ray Laboratory

Guangdong Technion
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广东以色列理工学院

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XRD@GTIIT

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X-ray Laboratory

广东以色列理工学院X射线实验室

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X-ray Lab

X射线实验室

Welcome to X-ray Laboratory!

The X-ray diffraction (XRD) laboratory was established in 2019 at the Guangdong Technion – Israel Institute of Technology (GTIIT).

X-ray diffraction Lab provides access to state-of-the-art equipment and technologies, hosts a crystallography course and X-ray diffraction application training. Moreover, offers advice and technical assistance in crystal growth, data collection and analysis to both internal and external users including academic institutions and industries.

Currently, the lab host two XRD equipment that can fit the needs of various levels of experiments and characterization, ranging from convention powder diffraction to high-resolution, Grazing incident X-ray diffraction, In-situ high temperature etc.

欢迎来到XRD实验室！

x射线衍射(XRD)实验室于2019年在广东以色列理工学院(GTIIT)成立。

X射线衍射实验室提供最先进的设备和技术，举办晶体学课程和X射线衍射应用培训。此外，在晶体生长、数据收集和分析方面向内部和外部用户（包括学术机构和工业界）提供咨询和技术援助。

目前，实验室拥有两台XRD设备，从常规粉末衍射到高分辨率、掠入射X射线衍射、原位高温等，可满足不同层次实验和表征的需要。

Equipment :

Rigaku SmartLab and MiniFlex

Rigaku SmartLab XRD

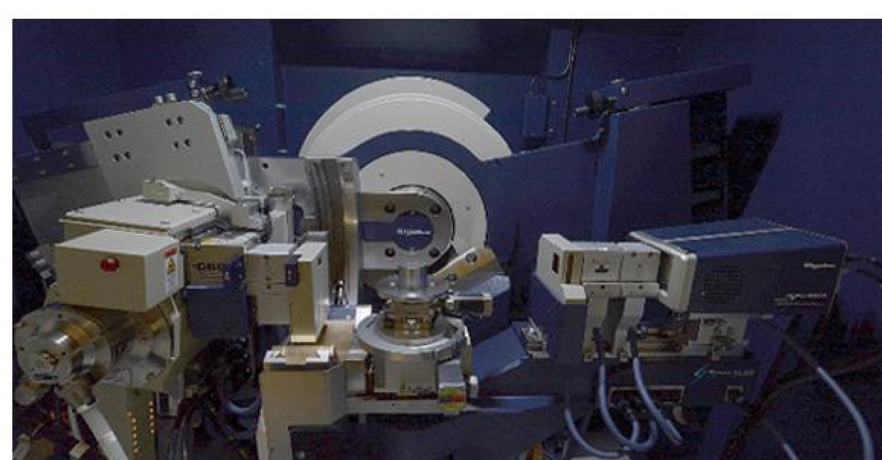
X-ray Tube: Cu target 9KW (45kV – 200mA)
Detector: 1D detector, 2D detector
Typical Applications:
Bragg-Brentano powder diffraction
High resolution XRD (HRXRD)
X-ray reflectivity (XRR)
Grazing incidence XRD (GIXRD)
In plane grazing incidence XRD
Small Angle X-ray Scattering (SAXS)
High speed in-situ measurement
Pole figure measurement
In situ High-Temperature XRD
Out-of-Plane and In-Plane Measurement

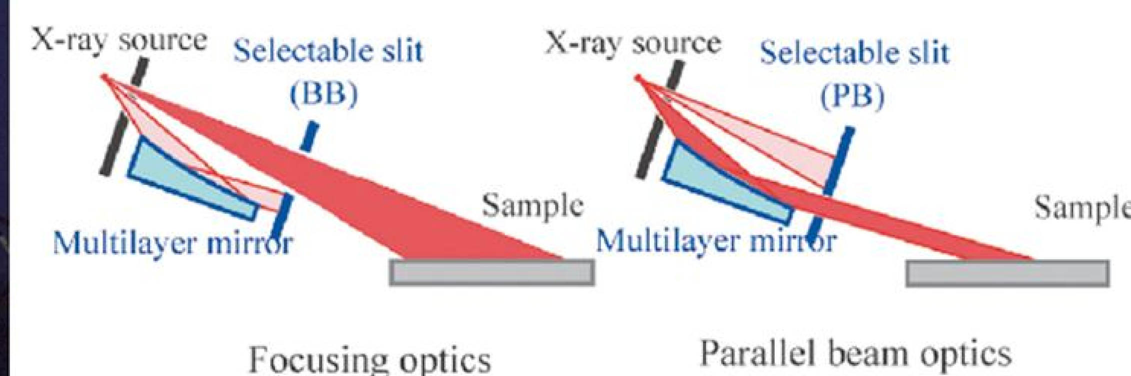
Rigaku MiniFlex600 XRD

X-ray Tube: Cu target 600W (40KV-15mA)
Scan Axis: theta/2-theta
Detector: D/teX Ultra2 1D detector
Functions:
Phase identification Qualitative and quantitative analysis Crystal structure characterization
Materials, chemistry, geology, food, pharmaceutical, and environmental studies

XRD SmartLab

常规XRD SmartLab





Conventional 1D scan

常规一维扫描

Bragg-Brentano and Parallel Beam optics

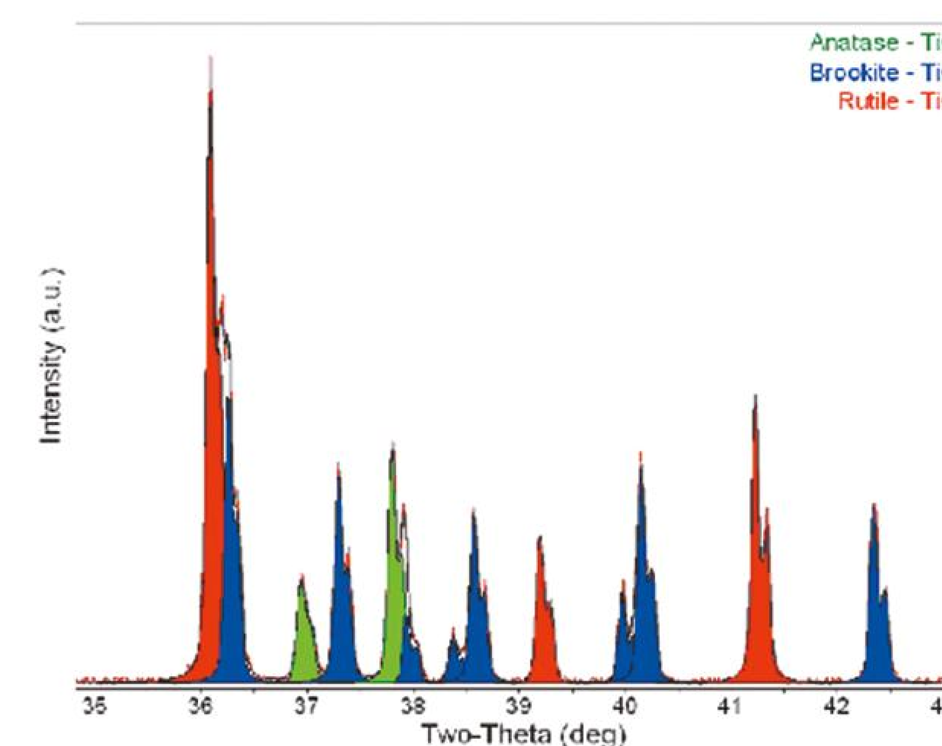
BB和PB光路

Bragg-Brentano geometry is the most commonly used technique for studying powder, bulk, and thin-film materials. However, our equipment can produce a parallel beam using multilayer mirrors. In this case,even for a rough sample, the peak shape,position, and FWHM are maintained.

在研究粉末、块体和薄膜的衍射时，布伦塔诺几何是最常规的。我们的设备可以使用多层反射镜产生平行光束。在这种情况下，即使是一个粗糙的样本,谱峰形状、位置和FWHM都保持不变。

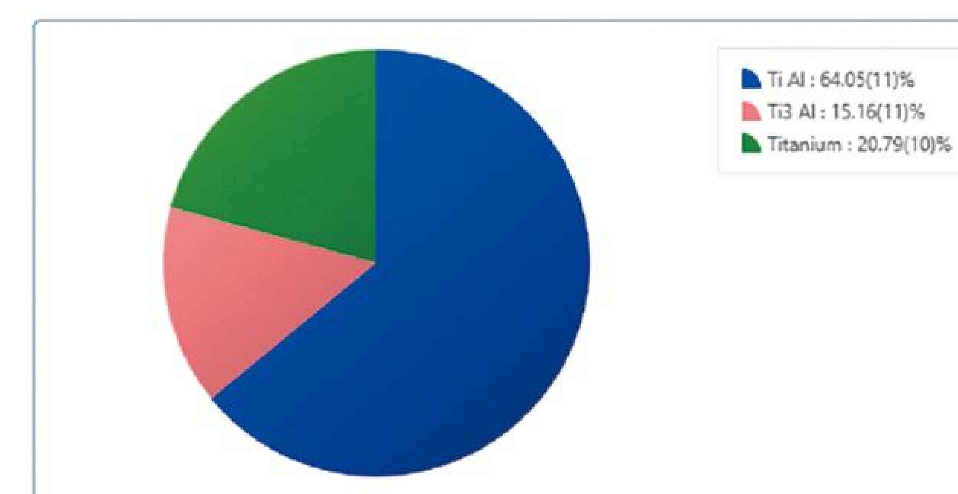
XRD MiniFlex

常规XRD MiniFlex



Phase Identification

物相鉴定



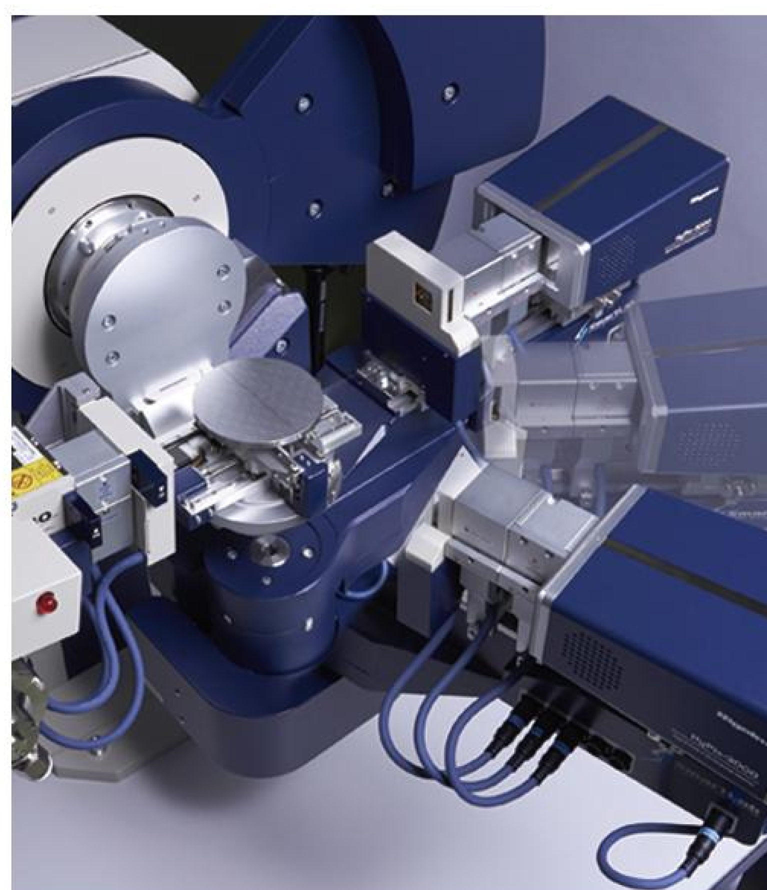
Quantitative Phase Analysis

定量分析

- Phase identification
- 物相检测
- Quantitative Phase Analysis
- 定量分析
- Crystallite size and microstrain
- 晶粒尺寸分布和微畸变
- Crystal structure
- 晶体结构分析
- Crystallinity 结晶度分析
- …

In-plane XRD-useful for thin film

面内XRD

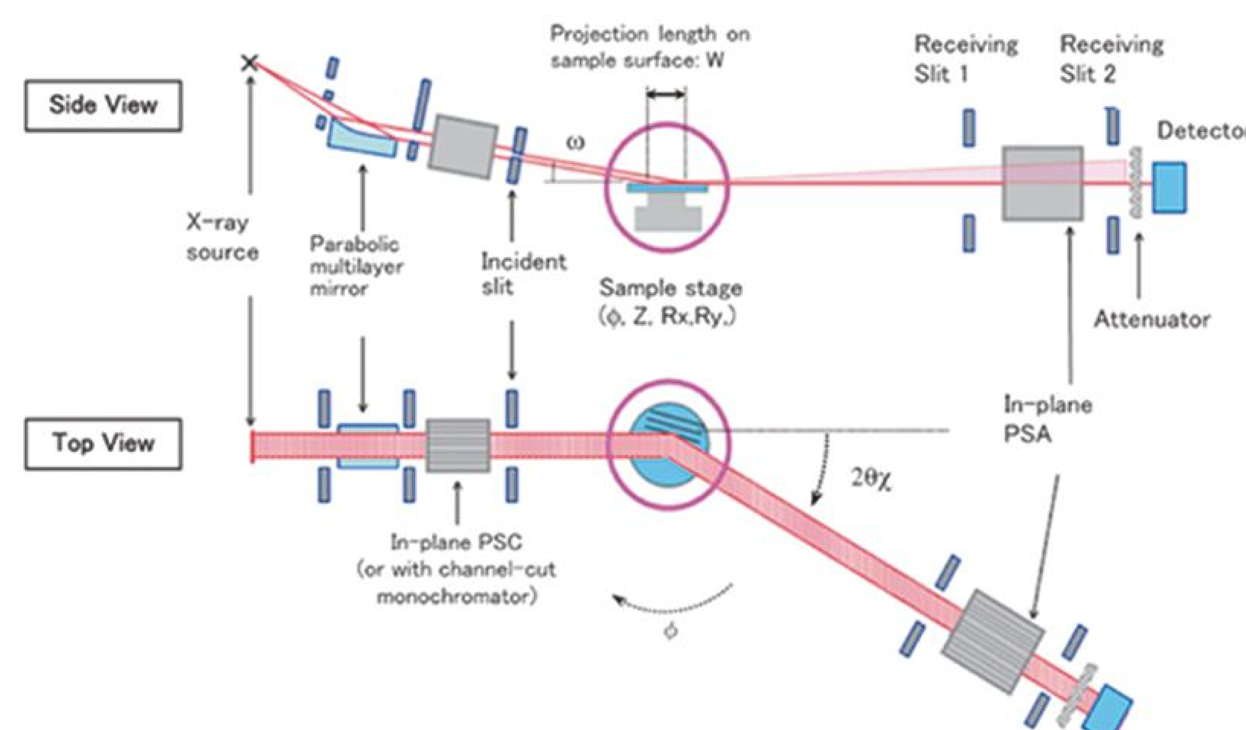


In-plane scan

面内扫描

With standard diffraction geometries, if the sample layer is too thin, X-rays are completely transmitted by the sample and no diffraction is observed. In these circumstances, in-plane diffraction is used mainly for thin film characterization.
In-plane diffraction has two major features: The penetration depth of the beam is limited to within about 100 nm of the surface and lattice planes that are (nearly) perpendicular to the sample surface are measured, which are inaccessible by other techniques.

在常规测试中，如果薄膜太薄，X光会穿过薄膜，观察不到衍射峰。这时，就会用到面内衍射。面内衍射有两个主要特点：光束的穿透深度被限制在表面约100纳米内，那些(几乎)垂直于样品表面的晶面被测量，这是其他技术无法达到的。

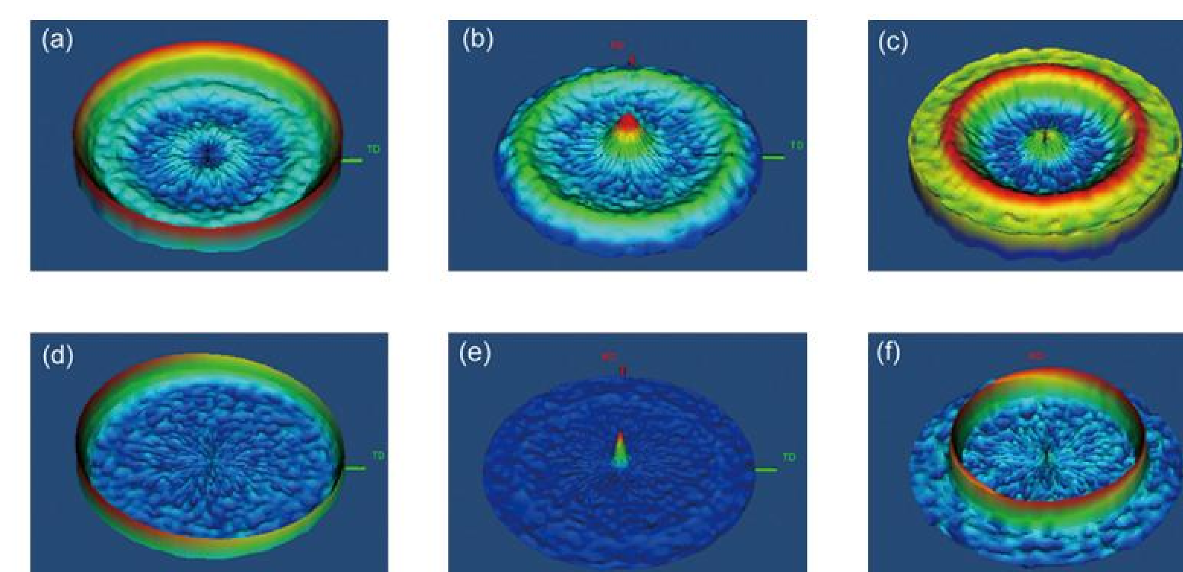


Schematic of the in-plane axis

面内轴图示

Pole Figure

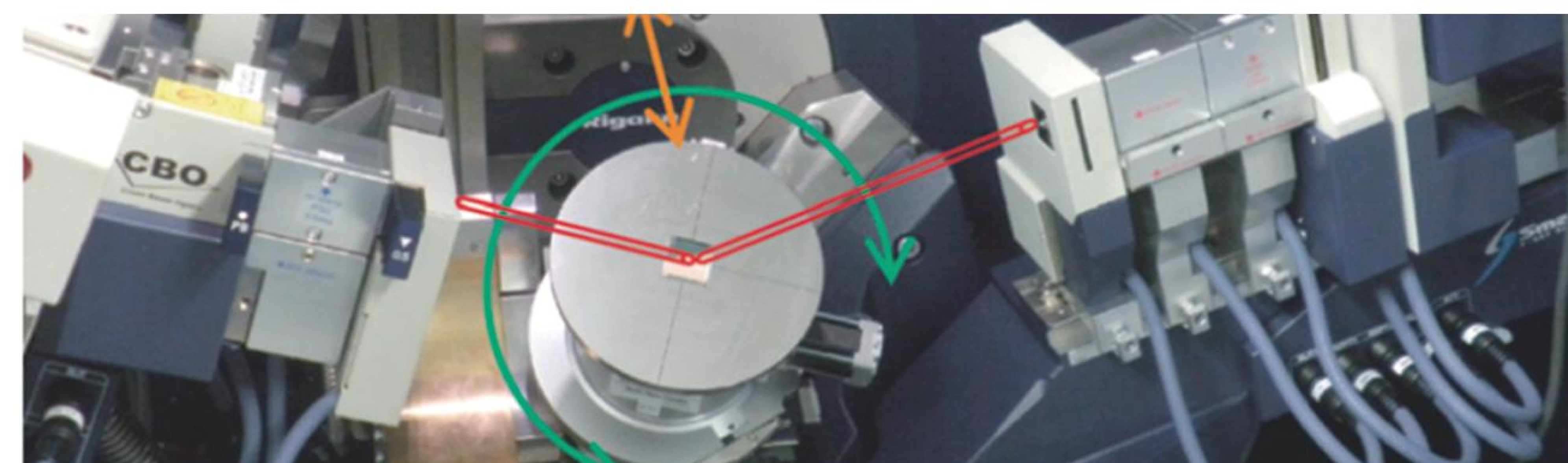
极图



(a) to (c): ZnO thin film with weak texture.
(a): 1100 reflection, (b): 0002 reflection, (c): 1101 reflection.
(d) to (f): ZnO thin film with strong texture.(interface layer)
(d): 1100 reflection, (e): 0002 reflection, (f): 111reflection.

Data of pole figure using in-plane axis

面内极图测试下的强弱织构分析

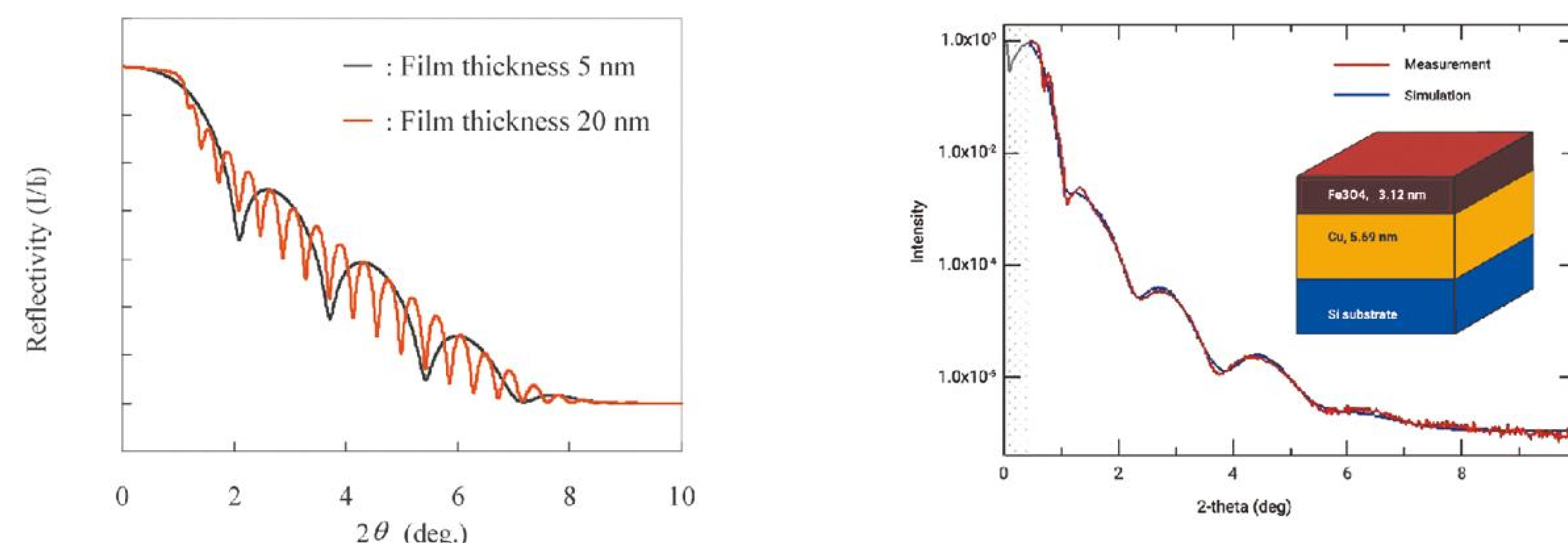


PF measurement

A pole figure (PF) measurement is an X-ray diffraction (XRD) technique employed for the observation of texture in polycrystalline materials, or the analysis of the orientation or domain configuration of epitaxial thin film.

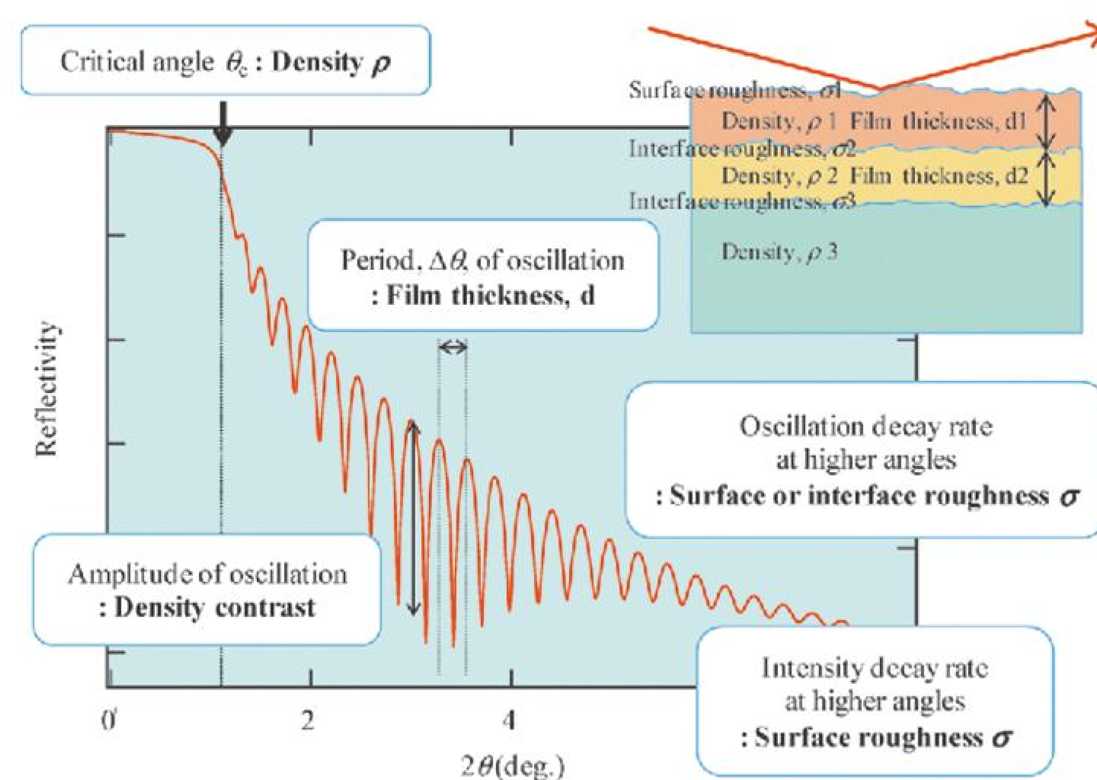
极图(PF)测量是一种x射线衍射(XRD)技术，用于观察多晶材料的织构，或分析外延薄膜的取向或畴结构。

ReflectivityXRR
反射率



Reflectivity of Au film on Si substrate
硅衬底上金膜的反射率

Simulation of the calculated layer structure
模拟计算出的层结构

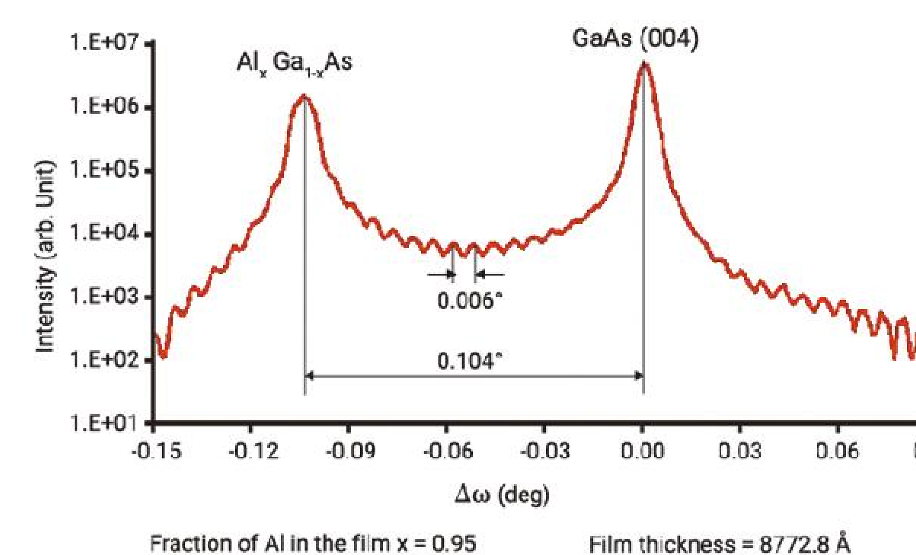


Information provided by X-ray reflectivity profile
X射线反射率谱图信息

The X-ray reflectivity technique is a method for determining the layer structure of a thin film - thickness, roughness, and density.

x射线反射率技术是一种测定薄膜层结构——厚度、粗糙度和密度的方法。

High-resolution XRD
高分辨XRD

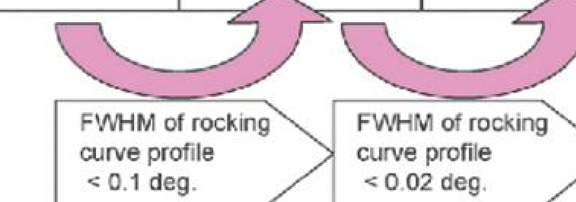


HRXRD used to analyze the composition and thickness

高分辨率x射线(HRXRD)
摇摆曲线常用于精确测定
外延合金薄膜的成分和厚度

How to select the monochromator
光学器件的功能和选择

Optics	Slit collimation	Ge(220) 2-bounce	Ge(220) 4-bounce
Resolution	0.05 deg.	0.01 deg.	0.0033 deg.
Monochromaticity of wavelength	K α_1 + α_2 (+Kβ)	K α_1	Part of K α_1
Relative intensity	1	1/20	1/100

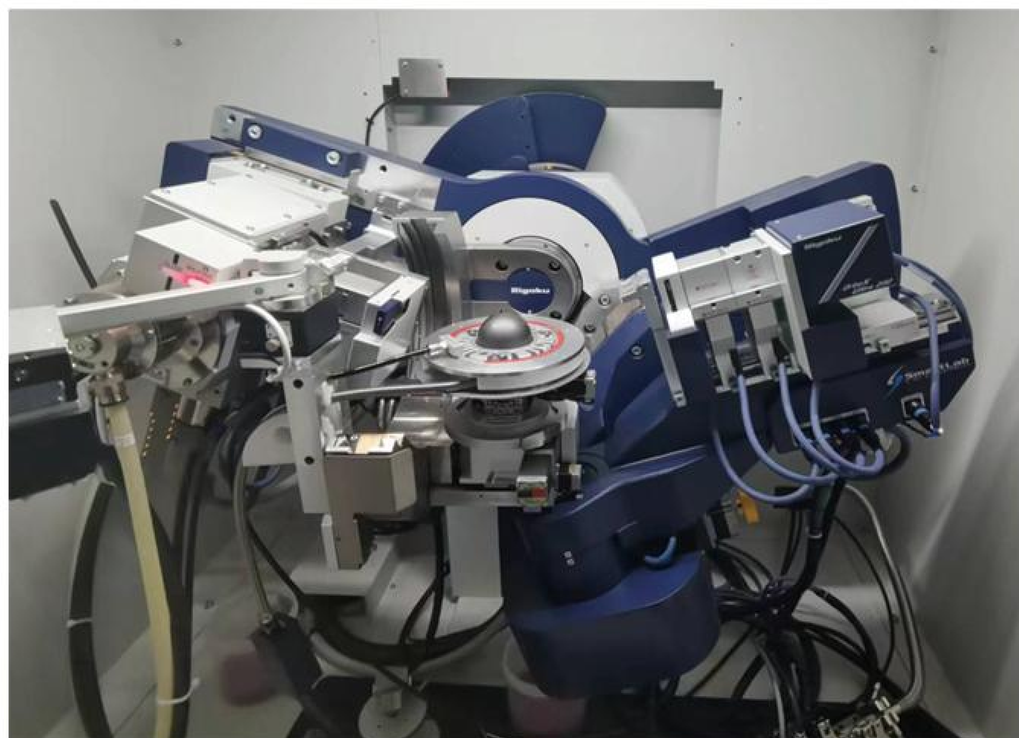


HRXRD is used to analyze epitaxial thin films which can determine composition, strain/relaxation, lattice parameters , thickness, and defect concentration.

利用HRXRD对外延薄膜进行分析，可以确定外延薄膜的组成、应变/弛豫、晶格参数(面内和面外)、厚度和缺陷浓度。

High-temperature XRD

原位高温XRD



In-situ high-temperature XRD

原位高温XRD

Anton Paar DHS1100 domed hot stage

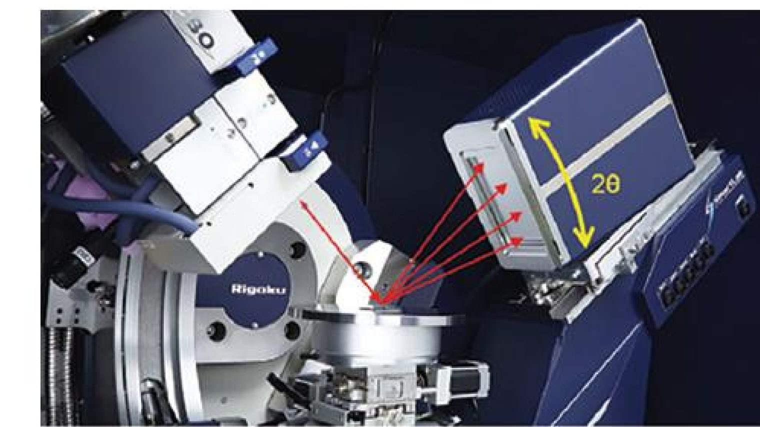
DHS1100高温台

Using HT-XRD that structural evolution of a material (such as temperature induced phase transitions) as a function of temperature can be examined. For this reason our lab is equipped with a high-temperature attachment that be operated under vacuum or inert gas atmosphere and can reach temperatures up to 1400 K.

高温XRD可以检测温度变化下材料的结构演变（如温度诱导相变）。因此，我们的实验室配备了高温附件，可在真空或惰性气体气氛下操作，温度可达1400 K。

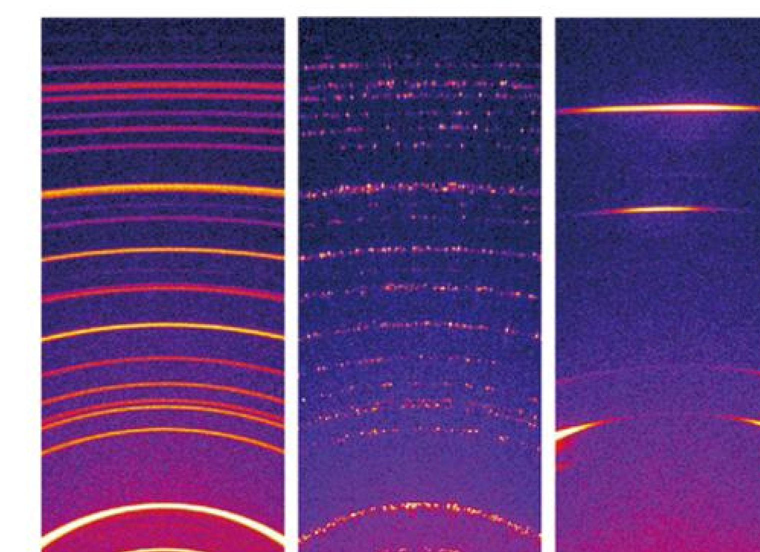
2D Detector

二维探测器



In-situ 2D exposure

原位二维曝光



1 2 3

2D picture 二维图片

Sensors	Semiconductor pixel sensor
Active area	2,984 mm^2 (77.5×38.5 mm)
Pixel size	100×100 μm
Number of pixels	775×385=298,375 pixels
Counter mode	Differential/31-bit/zero dead time
Count rate	Global: >2.9×10^{11} cps Local: >1×10^6 cps/pixel
Efficiencies	Cr, Fe, Co, Cu: 99% Mo: 38%
Readout time	3.7 ms (0 ms for zero dead time mode)
Energy resolution	Better than 25% at Cu $K\alpha$
Dimensions	147(W)×93(H)×180(D) mm
Weight	Approximately 2 kg

Specifications of HyPix-3000

1.Quartz (particle size: 10μm). 石英（10微米颗粒）

2.Quartz (particle diameter: 100μm). 石英（100微米颗粒）

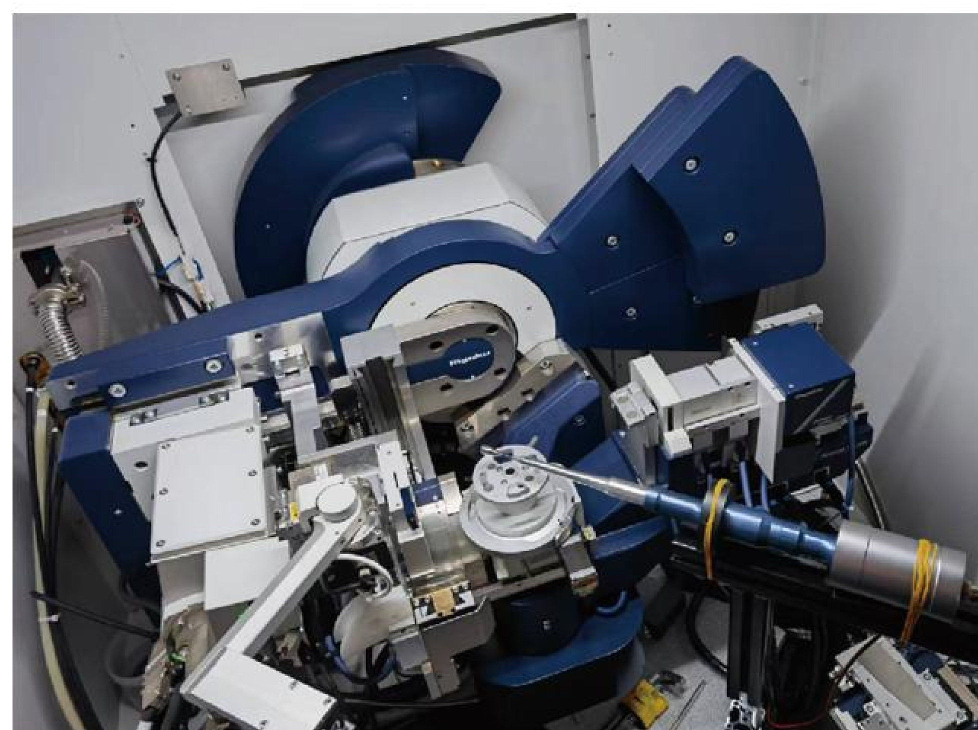
3.Aluminum (rolled plate). 铝（轧制板材）

Preferred orientation texture and coarseness of crystallites in a sample can be easily propped with 2D detector.
(Uniform Debye rings are observed with a sample that has sufficiently fine grain size and, on the other hand, discontinuous Debye rings consisting of dispersed spots are observed with the coarse grain size sample.)

利用二维探测器可以很容易地了解样品中晶体的择优取向、织构和粗度。(均匀的德拜环是用粒度足够细的样品观察到的，另一方面，由分散的斑点组成的不连续的德拜环是用粗粒度的样品观察到的。)

DIY XRD Measurement

自设计XRD实验



Design in-situ XRD experiment

设计原位实验

Close observation of the material

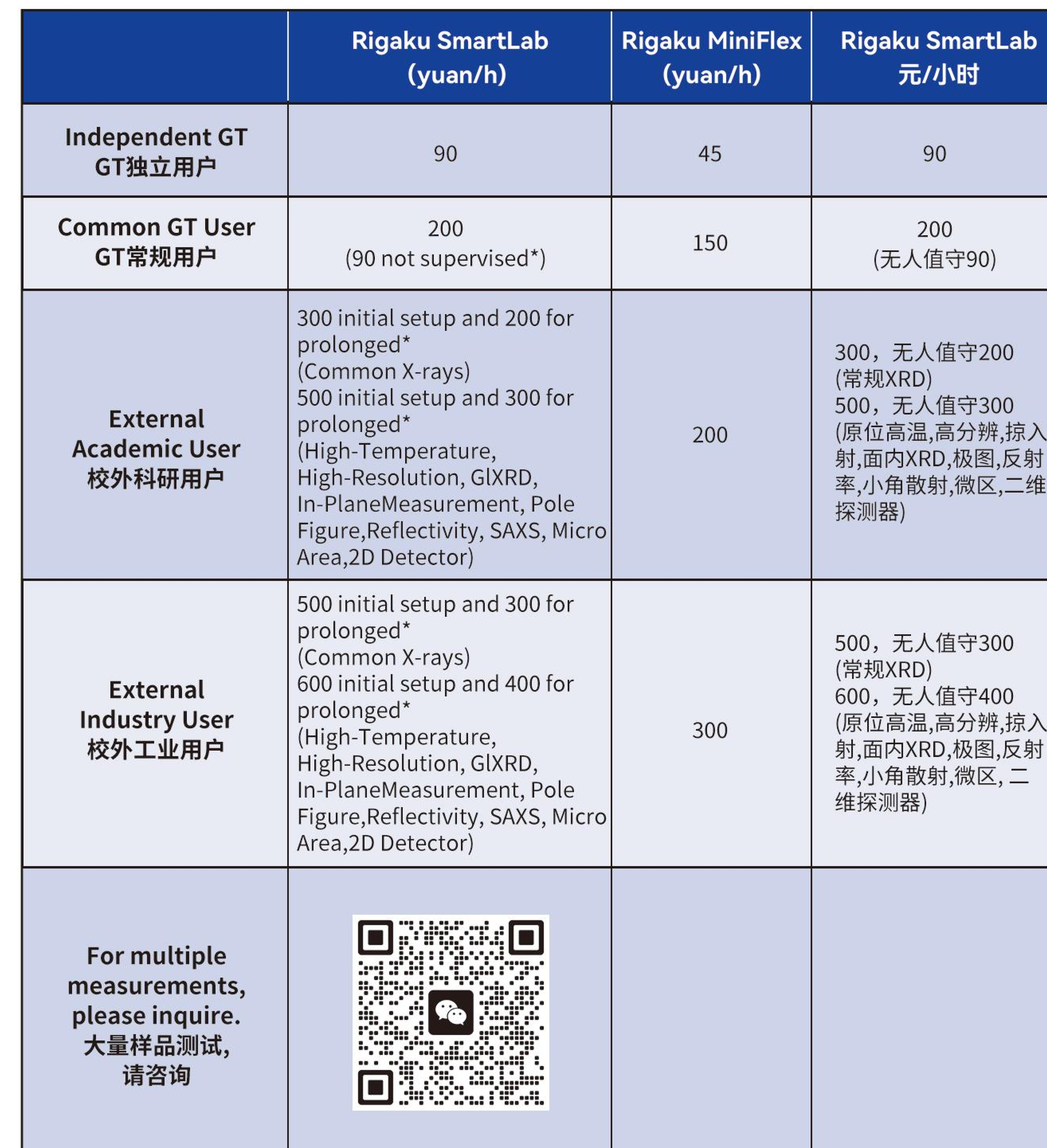
近距离观察材料变化

If you have questions or need for specific XRD measurements not discussed in this brochure you are welcome to contact us! We have already implemented quite a few user inspired XRD measurements.

如果您有任何疑问，或者需要在本手册中未讨论的特定XRD测量，欢迎与我们联系!我们已经实现了一些用户独特的XRD测量。

Charge

收费



	Rigaku SmartLab (yuan/h)	Rigaku MiniFlex (yuan/h)	Rigaku SmartLab 元/小时
Independent GT GT独立用户	90	45	90
Common GT User GT常规用户	200 (90 not supervised*)	150	200 (无人值守90)
External Academic User 校外科研用户	300 initial setup and 200 for prolonged* (Common X-rays) 500 initial setup and 300 for prolonged* (High-Temperature, High-Resolution, GIXRD, In-PlaneMeasurement, Pole Figure,Reflectivity, SAXS, Micro Area,2D Detector)	200	300，无人值守200 (常规XRD) 500，无人值守300 (原位高温,高分辨,掠入射,面内XRD,极图,反射率,小角散射,微区,二维探测器)
External Industry User 校外工业用户	500 initial setup and 300 for prolonged* (Common X-rays) 600 initial setup and 400 for prolonged* (High-Temperature, High-Resolution, GIXRD, In-PlaneMeasurement, Pole Figure,Reflectivity, SAXS, Micro Area,2D Detector)	300	500，无人值守300 (常规XRD) 600，无人值守400 (原位高温,高分辨,掠入射,面内XRD,极图,反射率,小角散射,微区, 二维探测器)
For multiple measurements, please inquire. 大量样品测试,请咨询			

* 300 for initial setup and measurements that need Lab Technician supervision.For prolonged measurements that do not need Lab Technician supervision the rate is 200 after initial setup.
*需要实验室技术员监督的初始设置和测试300。不需要实验室技术员监督的长时间测量，初始设置后200。