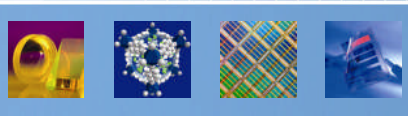
SOPRA
OPTICAL SOLUTIONS
for your Research

GXR5 E



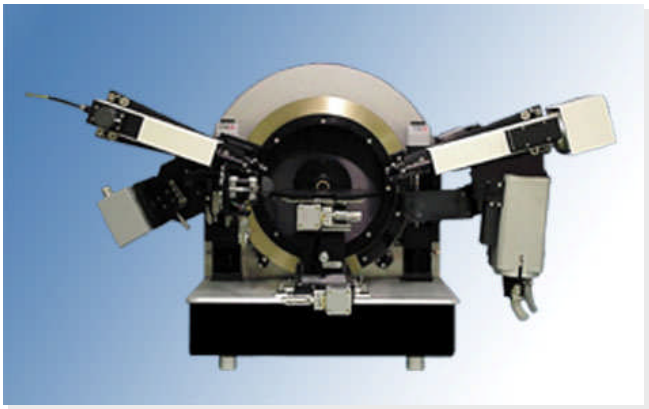
SPECTROSCOPIC ELLIPSOMETERS

Grazing X-Ray Reflectometry

Grazing X-Ray Reflectometry measures the X-Ray intensity reflected from a sample as a function of the angle θ between incoming beam and sample surface.
GXR technique is highly sensitive to the density contrast between materials.
When combined with Spectroscopic Ellipsometry, a technique sensitive to the optical contrast between materials, both techniques can solve unambiguously most complex layers stacks.

Capabilities

- Direct and absolute extraction of thickness in single multi-layers stacks
- Sensitivity to surface and interface roughness
- Combination with UV-VIS Spectroscopic Ellipsometry



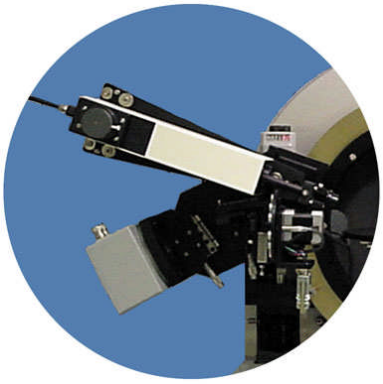
Specifications

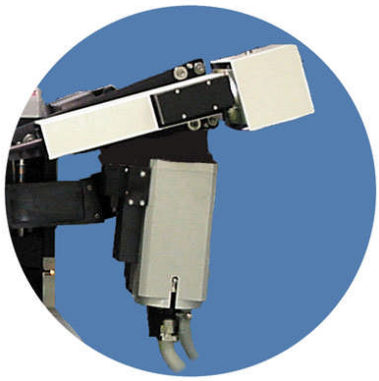
X-ray source

- 1.54Å Copper K-α line
- Curved-graphite monochromator optics
- Angular resolution: 0.01°

X-ray Detector

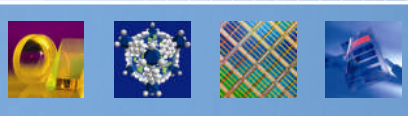
- NaI scintillator with Be window
- + Photo Multiplier Tube (dynamic range: 10^6)





SOFTWARE

- WINELLIX for Grazing X-Ray Reflectometry and combined Spectroscopic Ellipsometry
- + XRR data analysis



Options

- **Mapping**
  Automatic Rhô-Thêta for 200 & 300 mm wafers
- **Automatic tilt & Z adjustment**
  Z range=12 mm - Resolution=0,05 µm
- **XRD**
  X Rays Diffraction
- **Spectroscopic Ellipsometer combinations**
  Fast and/or High Resolution mode: 190-2000 nm (see GES5E brochure)
- **CCD camera monitor**

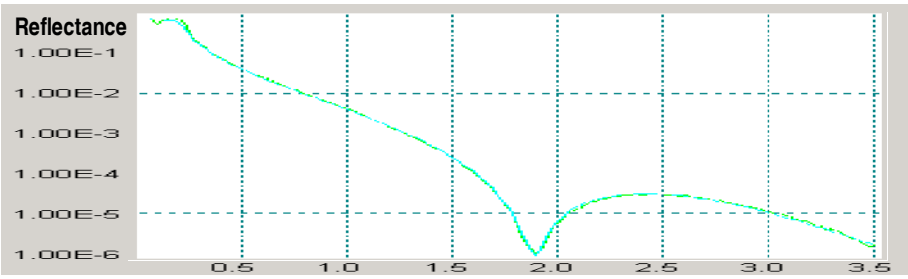
Applications

With more than 500 references worldwide SOPRA is owing to propose its customers the most accurate measurements on ever more complex structures.

Grazing X-Ray Reflectometry (GXR) is definitely the technique of choice for absolute thickness measurement of any type of materials: semiconductor, metallic, dielectric, organic, …
At this wavelength (1.54Å) every material displays the same refractive indices (n being 1 and k being 0, making considerably simpler the structural model for data analysis. In case of complex multilayers, accurate information can be obtained on the periodicity of stacks as well as on the interlayer structures.

- **High k dielectric films**
- **SiGe HBT structures**
- **Thin ONO layers stacks**
- **Thin gate oxide**
- **Anti-reflective coating**
- **Mo/Si multiplayers for EUV lithography**
- **Semiconductor epilayers GaAs, InSb, SiC, SiGe, HgCdTe**
- **Gold films**

HfO2 (3 nm) @ 1.54 Å



Model	T (nm)	±	Density (g/cm3)	±
Roughness	0.15	0.002		
Top layer (HfO2)	0.59	0.004		
Main layer (HfO2)	2.2	0.005	8.86	0.17

Total thickness: 2.94 ± 0.01 nm

Dielectric Material	Band gap (eV)	Dielectric Material	Thickness for tox = 1nm	Density (g.cm-3)	Delta ($*10^{-6}$)	Beta ($*10^{-6}$)
SiO_2	9	3.9	1	2.2	7.07	0.77
$Si3N_4$	5	7.5	1.9	3.44	11.08	1.29
SiON 10%	6	4.1	1.1	2.4	7.7	0.96
$Ta2O_5$	5.2	25	6.4	3.97	12.58	1.29
TiO_2	3.2	40	10.2	4.26	12.58	4.97
ZrO_2	5.5	20	5.2	3.52	10.8	2
$Hf0_2$	5.7	25	6.4	8.8	25.6	0.1

Band gap, dielectric constant and thickness for Tox= 1nm of several candidate gate dielectric materials.
Density and refractive index at 0.154nm are included.

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