

SCI FilmTek™ Systems(仪器型号及测试功能配置说明)

FilmTek™ systems are offered in a variety of configurations and capabilities in order to match every film measurement need and budget. These systems are computer controlled and offer full automation through simple to use recipe-based control software. The measurements are non-contact, and most can take place in as little as one second. The following table summarizes some of the features of the standard models. The large array of available options make it possible to tailor a FilmTek™ system according to the exact customer requirements.

Measurement Features 测量特征	FilmTek™ 1000	FilmTek™ 1500	FilmTek™ 2000	FilmTek™ 3000	FilmTek™ 2000SE	FilmTek™ 4000
Index of Refraction 折射指数 (at 2μm thickness)	±0.005	±0.005	±0.002	±0.002	±0.0002	±0.00002
Thickness Measurement Range 厚度测量范围	10nm-150mm	10nm-150mm	5nm-150mm	5nm-150mm	1Å-150mm	3nm-350mm
Maximum Spectral Range 最大光谱范围	380-1000nm	380-1000nm	190-1700nm	190-1700nm	190-1700nm	190-1700nm
Standard Spectral Range 标准光谱范围	380-1000nm	380-1000nm	240-860nm	240-860nm	240-1000nm	380-1000nm
Reflection 反射测量	✓	✓	✓	✓	✓	✓
Transmission 透射测量		✓		✓		
Optional Spectroscopic Ellipsometry 可选择的光谱椭 圆偏光法测量					✓	✓
Power Spectral Density 功率谱密度测量	✓	✓	✓	✓	✓	✓
Multi-angle Measurements (DPSD) 多角度测量						✓
Both TE & TM Components of Index						✓
Multi-layer thickness 多层厚度测量	✓	✓	✓	✓	✓	✓
Index of Refraction 折射系数测量	✓	✓	✓	✓	✓	✓
Extinction (absorption) Coefficient 消光(吸收)系数	✓	✓	✓	✓	✓	✓
Energy band gap 能量带隙测量			✓	✓	✓	✓
Composition 成分测量			✓	✓	✓	✓
Crystallinity 晶状测量			✓	✓	✓	✓
Inhomogeneous Layers 非均匀层测量			✓	✓	✓	✓
Surface Roughness 表面粗糙度测量			✓	✓	✓	✓
A variety of options can extend these standard measurement capabilities.						

Applications 应用

FilmTek™ metrology systems can measure a broad array of single and multi-layer films including metallic, semiconductor, amorphous, crystalline, and dielectric materials on virtually any substrate. FilmTek™ can simultaneously determine:

FilmTek™测量系统能测量宽范围的单层/多层薄膜, 包括任何衬底上金属(性)的, 半导体, 非结晶, 结晶, 电介质材料. FilmTek™能同时测定:

- Multiple layer thicknesses (from $<1\text{\AA}$ to 250 microns) 1Å 到 250 微米多层厚度测量
- Indices of refraction [$n(\lambda)$] (both TE and TM components of index)
- 折射指数 $n(\lambda)$ 测量
- Extinction (absorption) coefficients [$k(\lambda)$] 消光(吸收)系数测量
- Birefringence ()双折射
- Energy band gap [E_g] 能量带隙测量
- Surface roughness and damage 表面粗糙度和损伤测量
- Porosity, composition, and crystallinity (EMA model)有孔性,成分, 晶态(电磁加速模型)
- Film properties versus temperature 薄膜温度特性
- Wafer curvature and film stress 硅片曲率和薄膜应力

Optoelectronics Application Reports 光电子学应用报告

- Characterizing Oxide Films for Waveguide Applications 表现波导应用氧化物薄膜特性
- FilmTek™ 4000 Repeatability 可重复性
- Characterizing Film Properties versus Temperature 表现薄膜温度特性
- Measuring Color Coordinates: Colored Resists 测量彩色座标系:
- Characterizing OLED Display Materials 表现 OLED 有机发光二级管显示材料特性
- Characterizing Birefringent Materials: PET 表现双折射材料特性

Semiconductor Application Reports 半导体应用报告

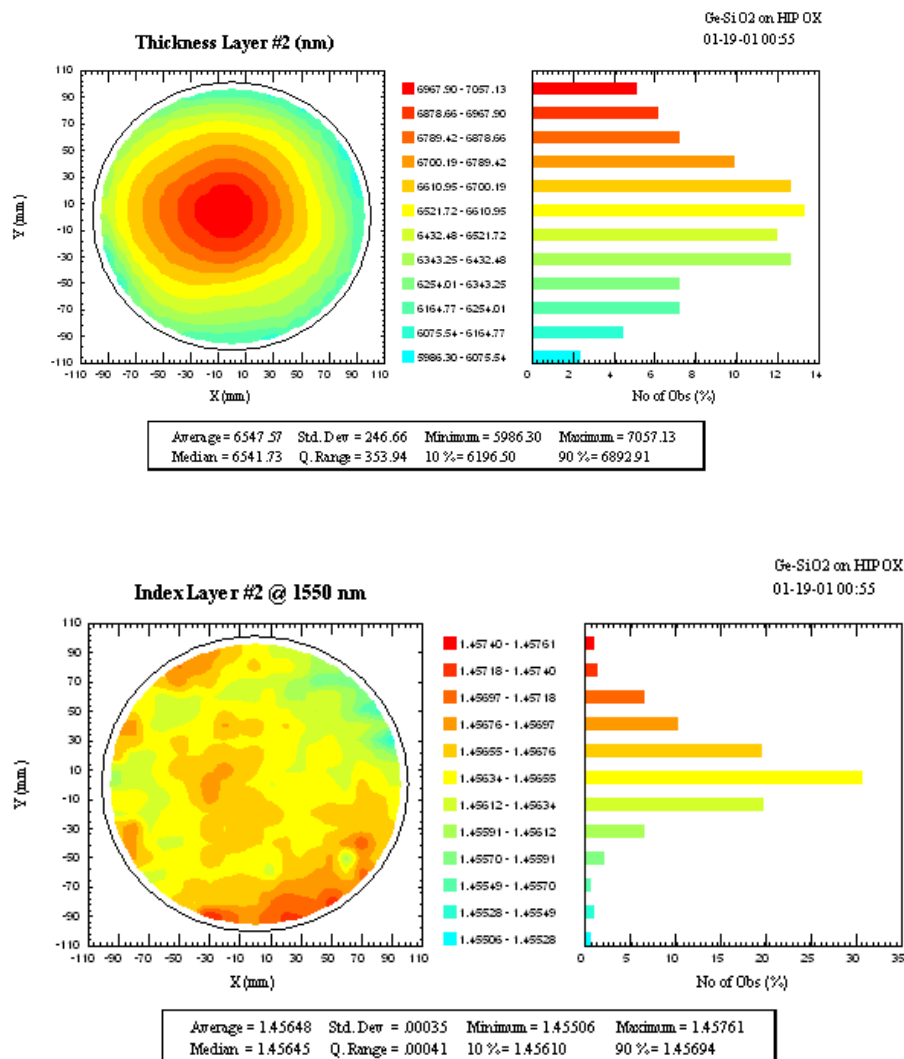
- Measuring Surface Roughness 测量表面粗糙度
- Characterizing Very Thin ONO Films 表现很薄薄膜特性
- Characterizing Advanced Low-k Materials 表现先进低 K 材料特性
- Characterizing High-k Materials 表现高 K 材料特性
- Characterizing SiGe 表现锗化硅特性
- Measuring Silicon on Insulator (SOI) Films 测量绝缘体上硅薄膜
- Characterizing Amorphous Silicon and Polysilicon 表现非晶硅和多晶硅特性
- Characterizing Silicon on Sapphire (SOS) 表现蓝宝石上硅薄膜特性
- Characterizing Photomasks 表现光掩膜特性

Characterizing Oxide Films for Waveguide Applications (表现波导应用氧化物薄膜特性)

FilmTek™ Advantages 优势

- FilmTek™ 4000 measures thickness and index of refraction independently with SCI's patented Differential Power Spectral Density (DPSD) technology.
- 基于 SCI 专利的示差功率谱密度技术 FilmTek™ 4000 测量厚度和折射指数
- Accurate and simultaneous determination of film thickness and index of refraction as a function of wavelength [$n(\lambda)$] (both TE and TM components of index).
- Measure optical properties from 190nm-1700nm.
- FilmTek™ 4000 has the highest resolution and repeatability in the industry, with a thickness resolution of 2Å and index resolution of 2×10^{-5} .
- 厚度分辨率 2Å, 折射指数分辨率 2×10^{-5} .

6.5μm Ge-SiO₂/15μm SiO₂/Silicon Substrate (6.5μm 锗-二氧化硅/15μm 二氧化硅/硅衬底)

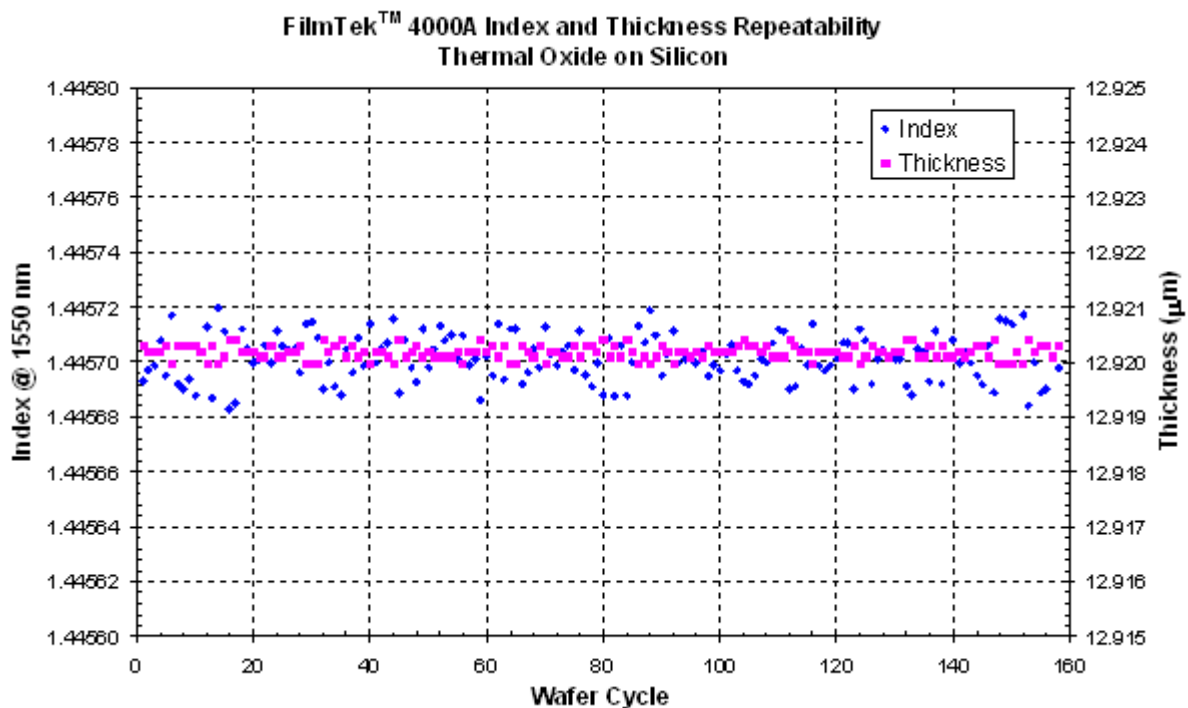


FilmTek™ 4000 Repeatability(可重复性)

FilmTek™ Advantages 优势

- FilmTek™ 4000 measures thickness and index of refraction independently with SCI's patented Differential Power Spectral Density (DPSD) technology.
- 基于 SCI 专利的示差功率谱密度技术 FilmTek™ 4000 测量厚度和折射指数
- Accurate and simultaneous determination of film thickness and index of refraction as a function of wavelength [$n(\lambda)$] (both TE and TM components of index).
- Best index and thickness repeatability in the industry.
- 工业中最好的折射指数和可重复性测试

FilmTek™ 4000A Index and Thickness Repeatability: 160 Wafer Load/Unload Cycles 折射指数和可重复性测试 :160 晶片加载/卸载循环



Characterizing Film Properties versus Temperature

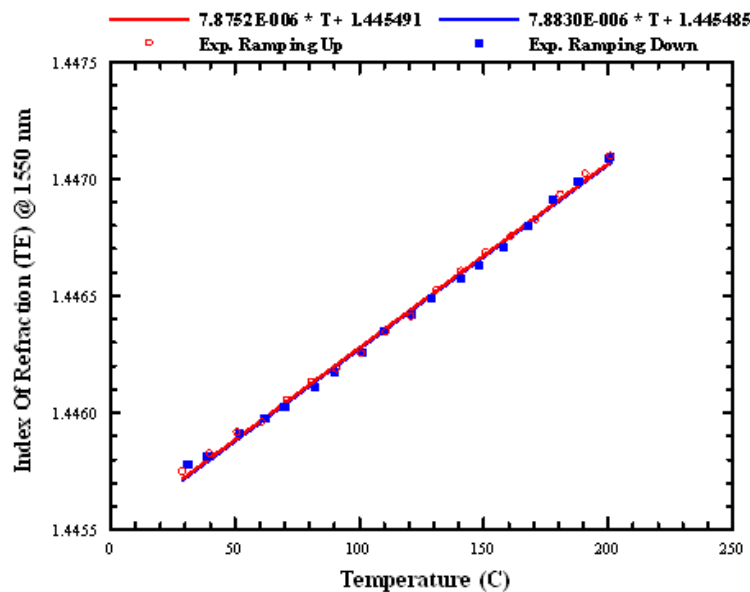
(表现薄膜温度特性)

FilmTek™ Advantages 优势

- The high index and thickness resolution of the FilmTek™ 4000 allows film properties to be accurately characterized as a function of temperature.
- Measure dn/dT and thermal expansion coefficients for new materials.
- Thermal characterization of films provides a quick measure of environmental stability for process research and development.

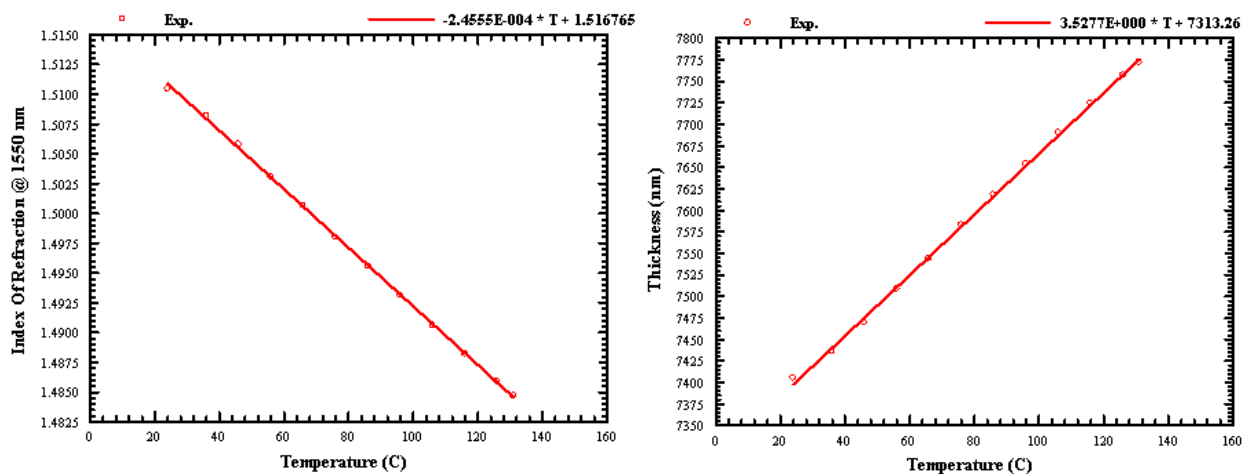
Measured Index of Refraction versus Temperature of SiO₂ on Silicon

硅上二氧化硅薄膜折射系数温度特性测量



Characterization of a Tunable Polymer Waveguide Material versus Temperature

可调聚合体波导材料温度特性测量



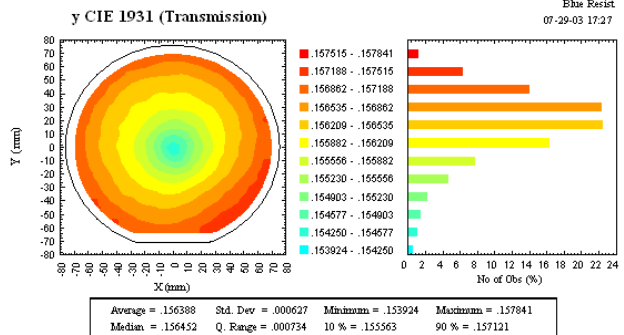
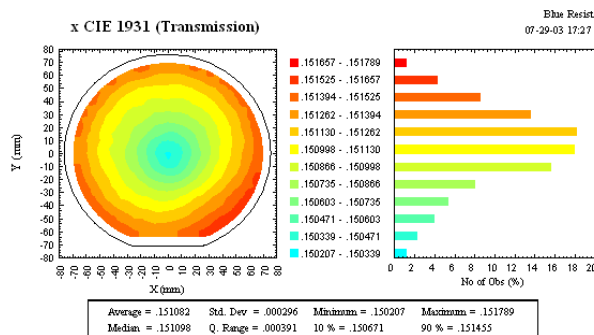
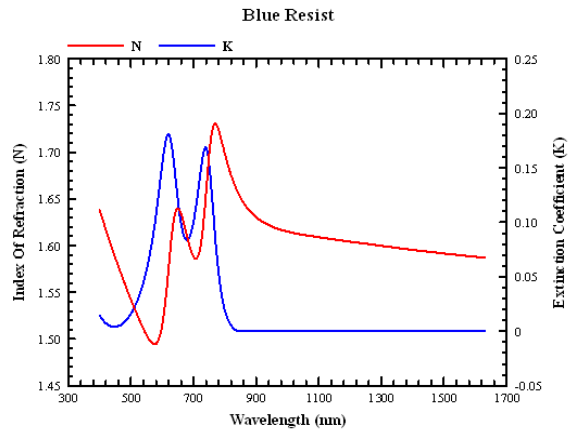
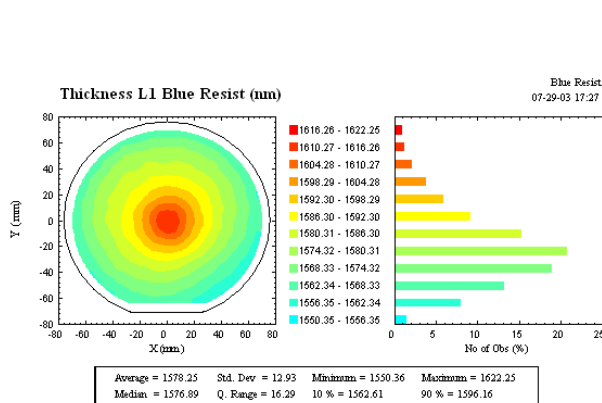
Measuring Color Coordinates: Colored Resists

(测量彩色坐标系)

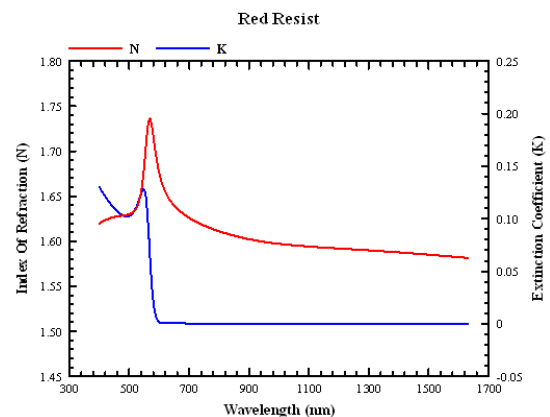
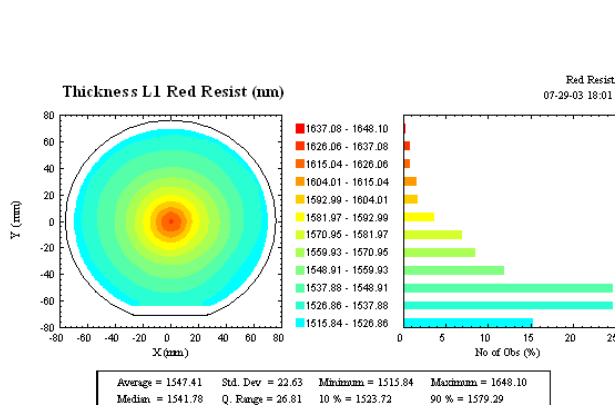
FilmTek™ Advantages 优势

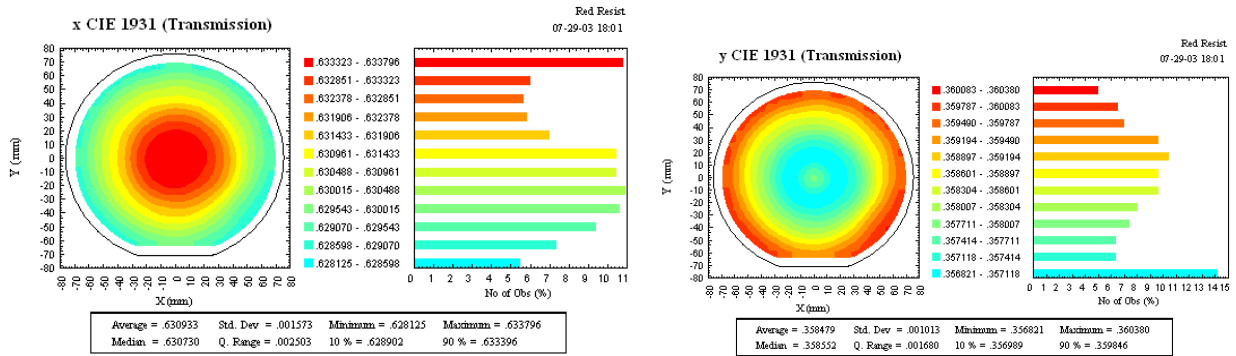
- FilmTek™ simultaneously measures thickness, optical constants, and CIE color coordinates. 同时测量厚度, 光学常数, 相干红外能量彩色坐标系
- Superior film characterization enables accurate and repeatable process monitoring.

Measuring Colored Resists on Silicon > Blue Resist

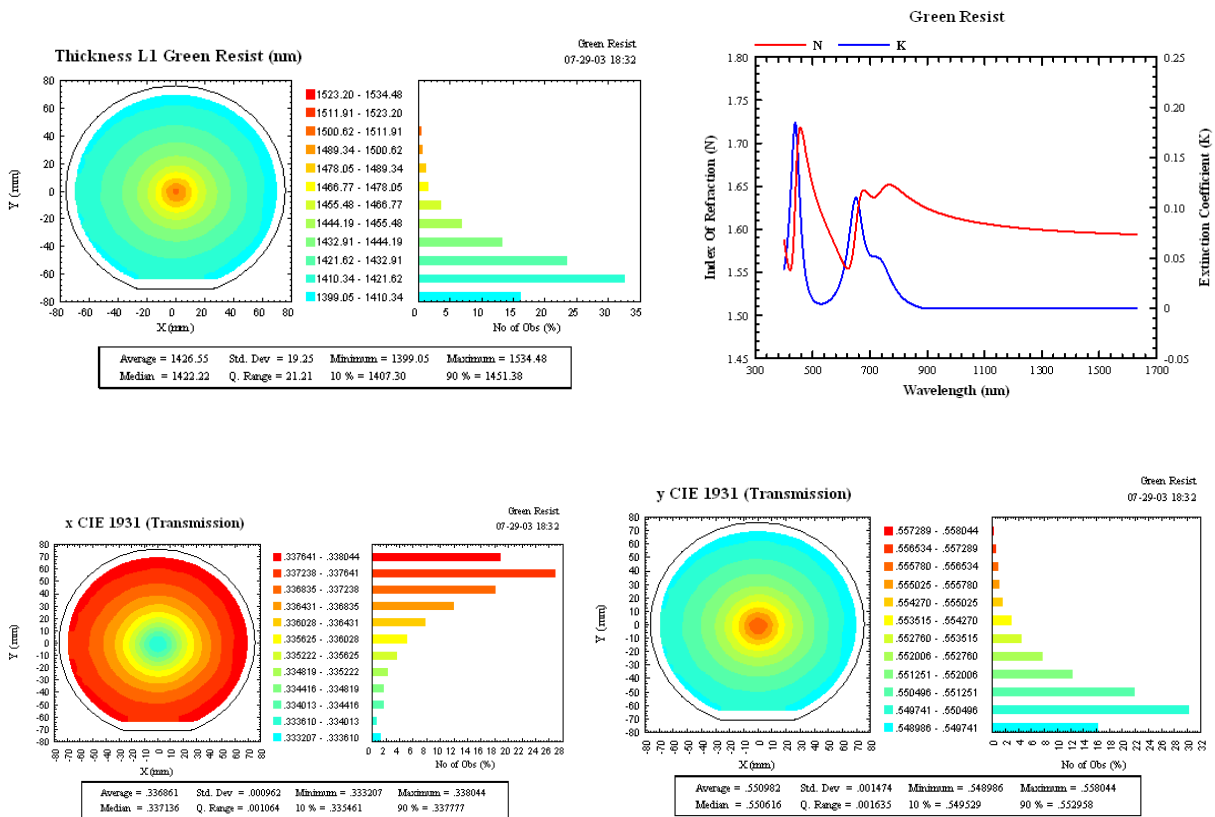


Measuring Colored Resists on Silicon > Red Resist

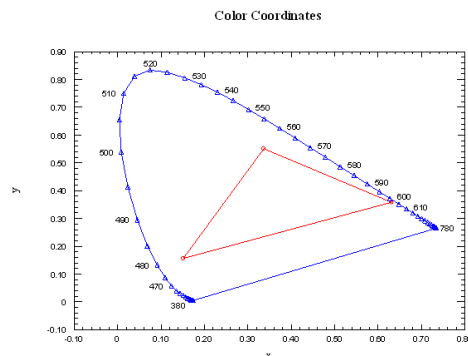




Measuring Colored Resists on Silicon > Green Resist



Measuring Colored Resists on Silicon > CIE Color Coordinates

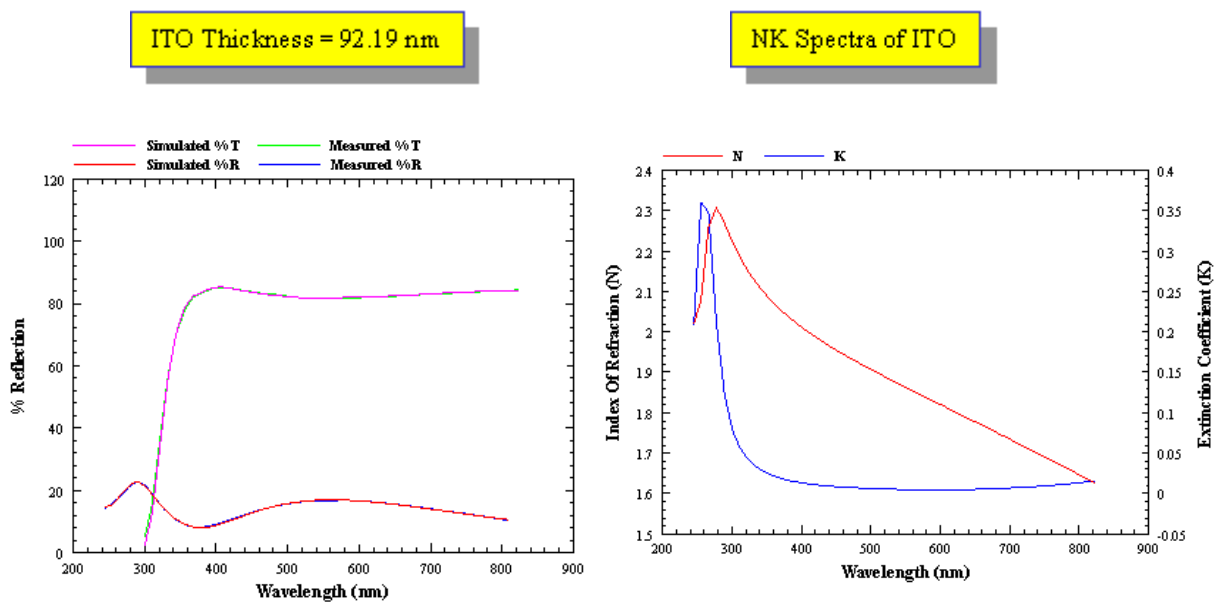


Characterizing OLED Display Materials (表现 OLED 有机发光二极管显示材料特性)

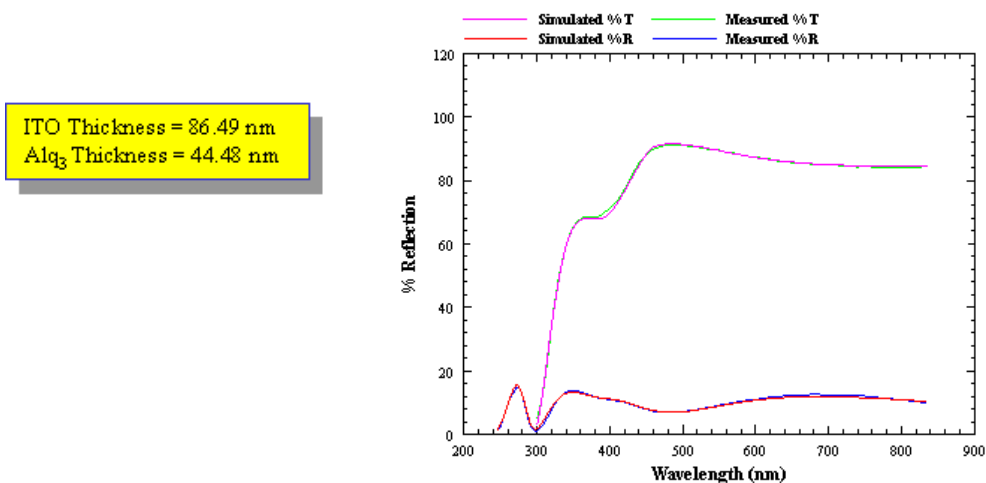
FilmTek™ Advantages 优势

- FilmTek™ 3000 measures spectroscopic reflection and transmission.
- FilmTek™ 3000 光谱反射和透射测量
- Accurate and simultaneous determination of film thickness and index of refraction as a function of wavelength [$n(\lambda)$].
- Simultaneous measurement of multiple OLED layer thicknesses.
- Advanced process control achieved with FilmTek's™ high resolution measurement of optical constants and thickness.

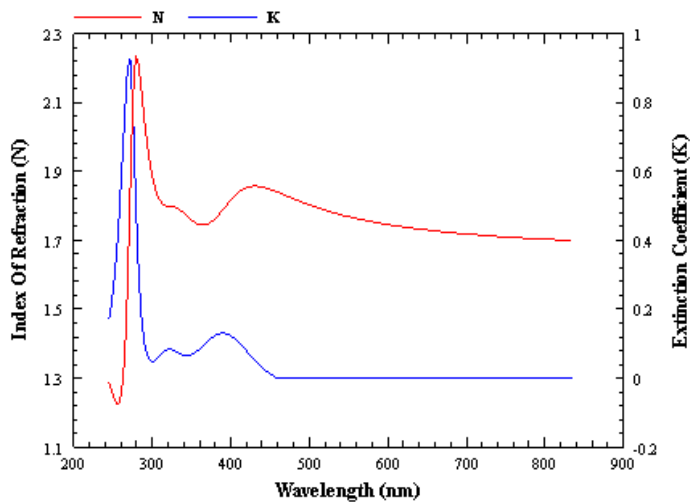
ITO/Glass



Alq₃/ITO/Glass

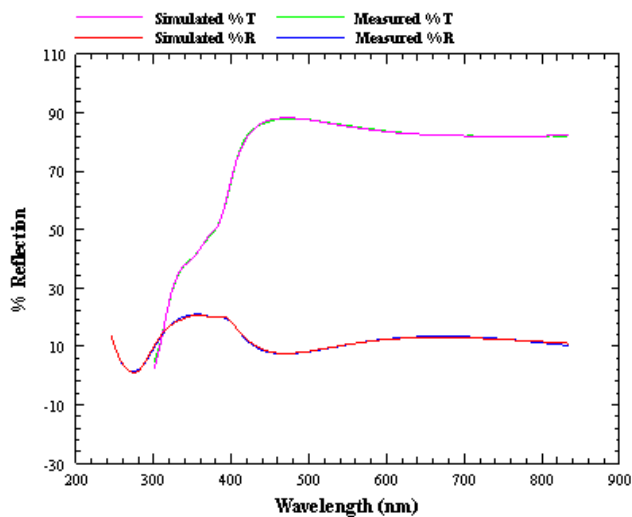


NK Spectra of Alq_3

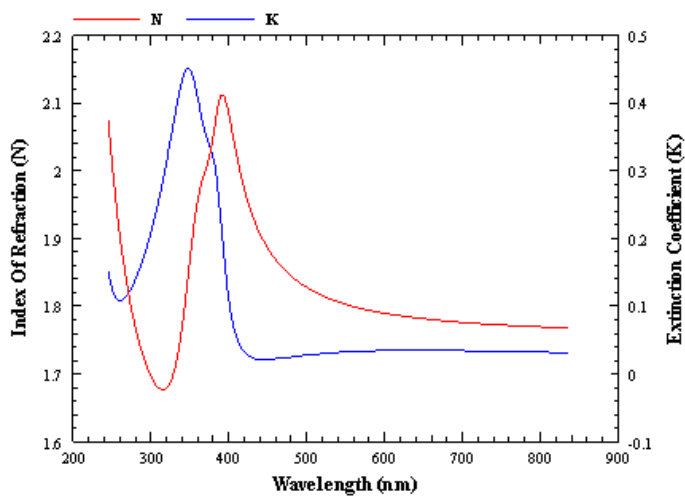


NPB/ITO/Glass

ITO Thickness = 89.90 nm
NPB Thickness = 35.67 nm



NK Spectra of NPB



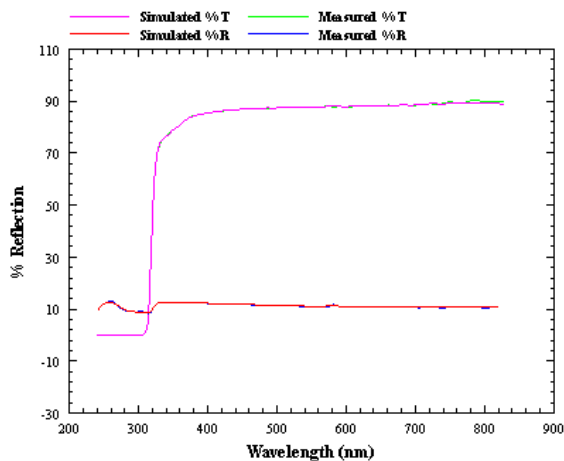
Characterizing Birefringent Materials: PET (表现双折射材料特性)

FilmTek™ Advantages 优势

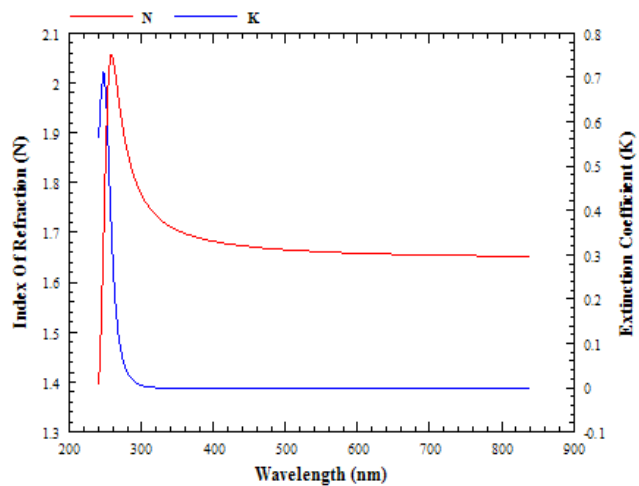
- FilmTek™ 3000P combines spectroscopic reflection, transmission, and polarimetry measurements for the accurate and simultaneous determination of optical constants and birefringence ($n_e - n_o$). 光谱反射, 透射, 偏振测定测量
- Simultaneous measurement of multi-layer films on birefringent substrates.
- Advanced process control achieved with FilmTek's™ high resolution measurement of optical constants, birefringence, and thickness.

PET Film

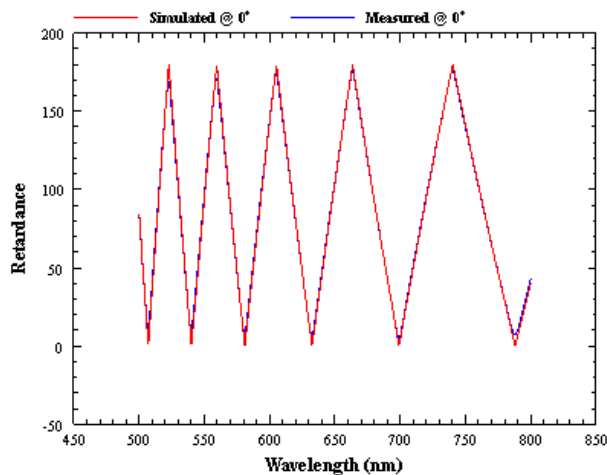
Reflection/Transmission Spectra of PET



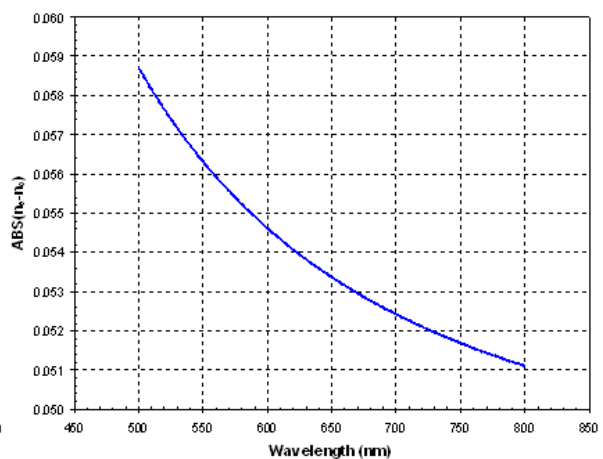
NK Spectra of PET



Retardance of PET



Birefringence of PET

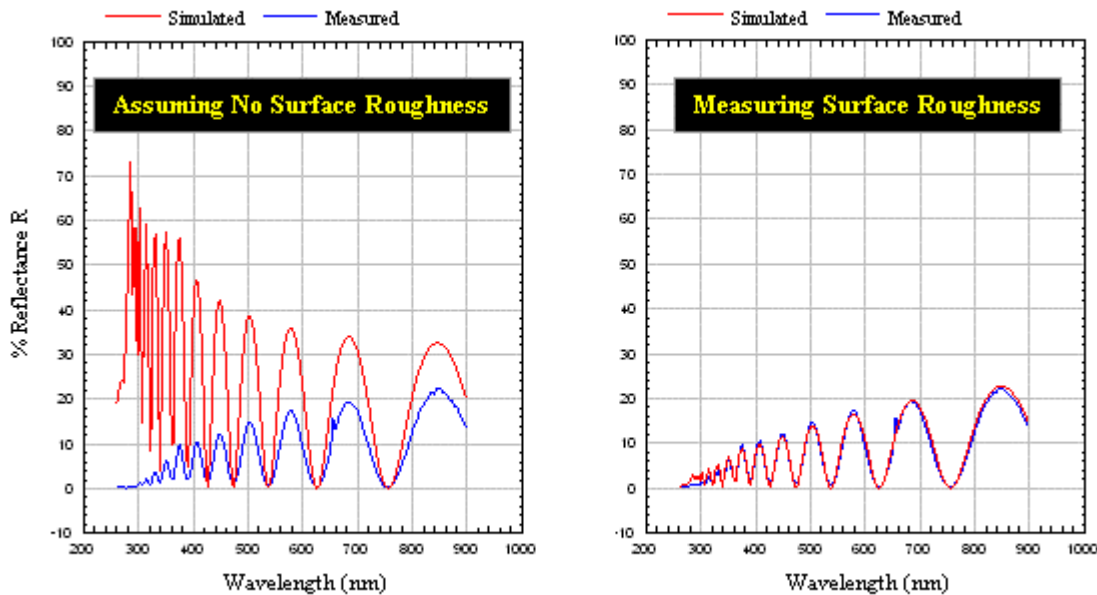


Measuring Surface Roughness(测量表面粗糙度)

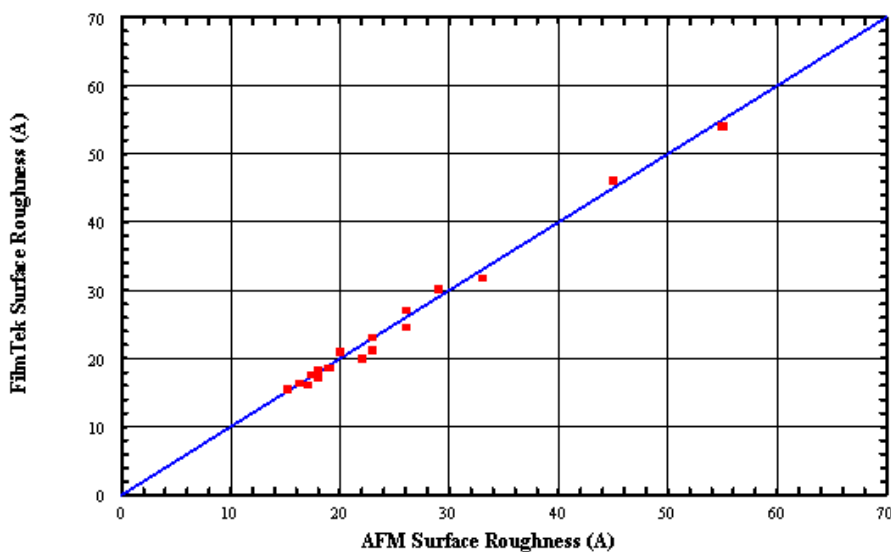
FilmTek™ Advantages 优势

- Fast, non-contact surface roughness measurement. 快速的,非接触表面粗糙度测量
- FilmTek™ simultaneously measures surface roughness, thickness, and optical constants (nk spectra).

SrS Film with 40nm RMS Surface Roughness 40nm 均方根表面粗糙度

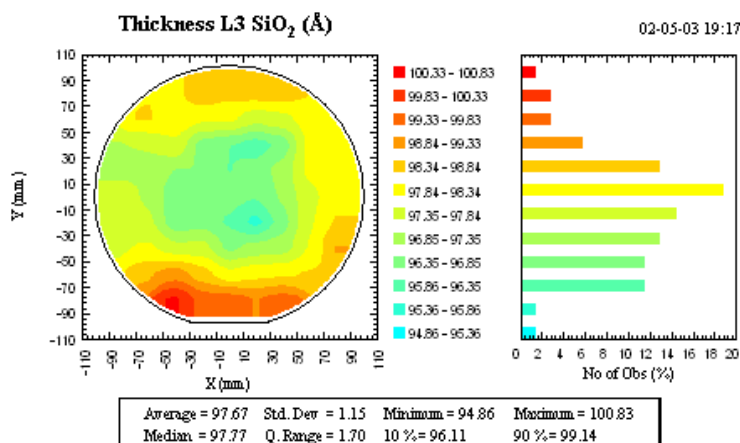
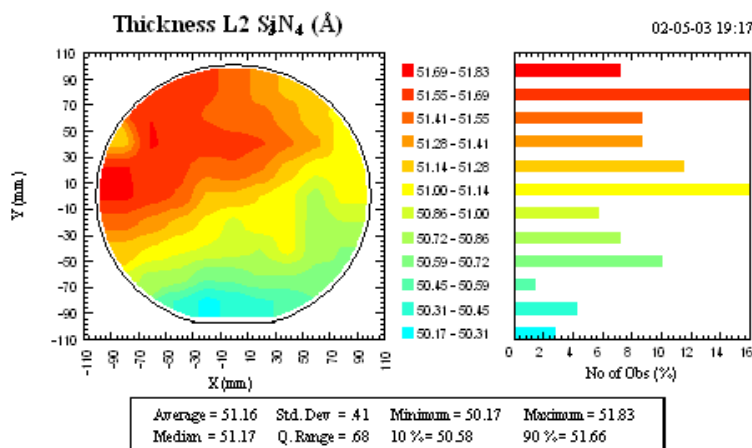
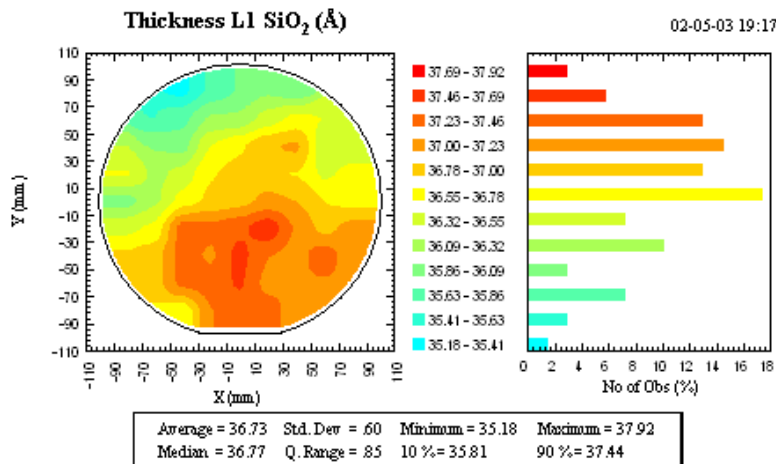


FilmTek™ Surface Roughness Correlation with Atomic Force Microscopy (AFM) FilmTek™-原子力显微镜表面粗糙度测试比较



Characterizing Very Thin ONO Films(表现很薄 ONO 薄膜特性)

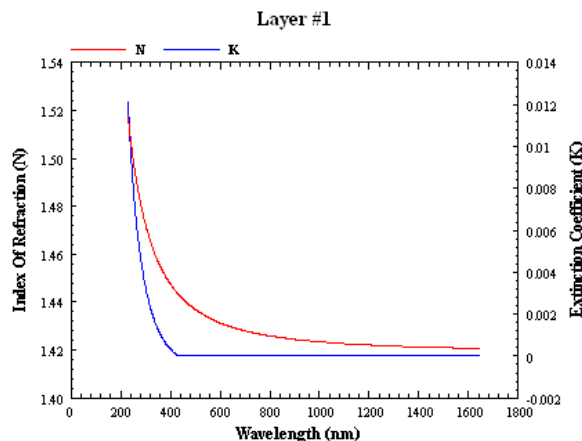
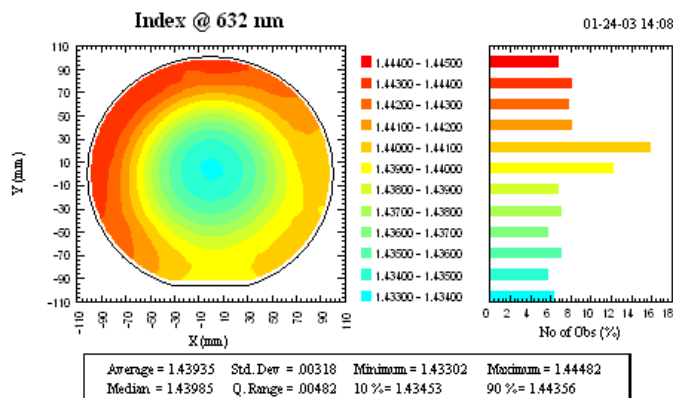
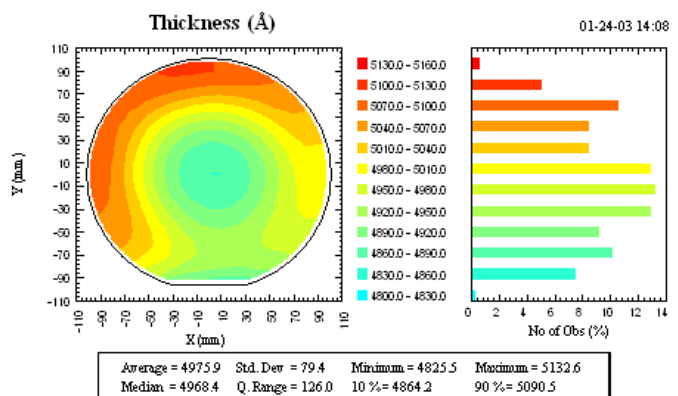
- Simultaneous measurement of all three oxide/nitride/oxide (ONO) layers.
- 同时测量三层薄膜(氧化物/氮化物/氧化物)
- FilmTek 4000EM-DUV combines spectroscopic ellipsometry with deep UV reflectometry using SCI's patented Multi-Angle Differential Polarimetry (MADP) technology to discriminate between the top and buried oxide layers.
- FilmTek 4000EM-DUV 基于 SCI 专利的示差功率谱密度技术并结合紫外反射计和光谱椭圆偏光计鉴别顶层和隐藏层氧化物.



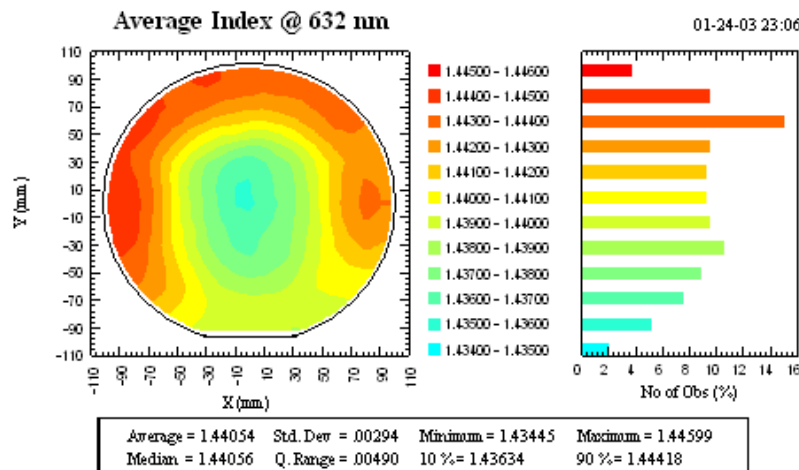
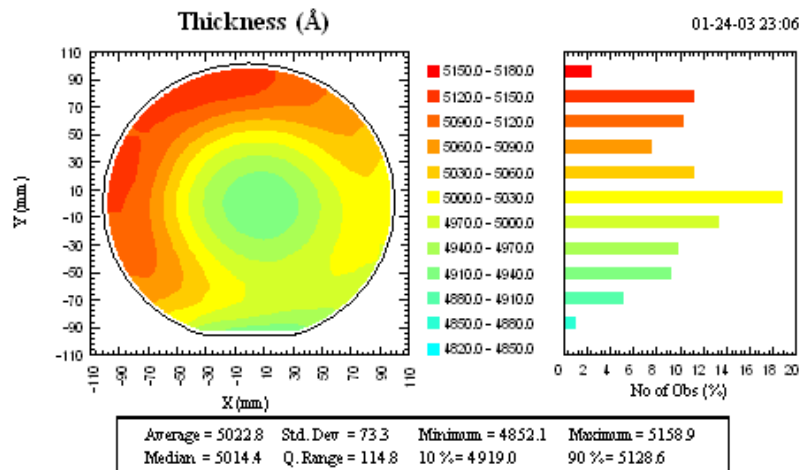
Characterizing Advanced Low-k Materials (表现先进低 K 材料特性)

- Advanced process control achieved with FilmTek's™ high resolution measurement of optical constants and thickness using SCI's patented Differential Power Spectral Density (DPSD) technology.
- Measure graded low-k films (e.g., after plasma damage) with SCI's advanced modeling algorithms.
- Superior film characterization enables accurate and repeatable CMP and trench depth process monitoring of multi-layer low-k film stacks on copper.

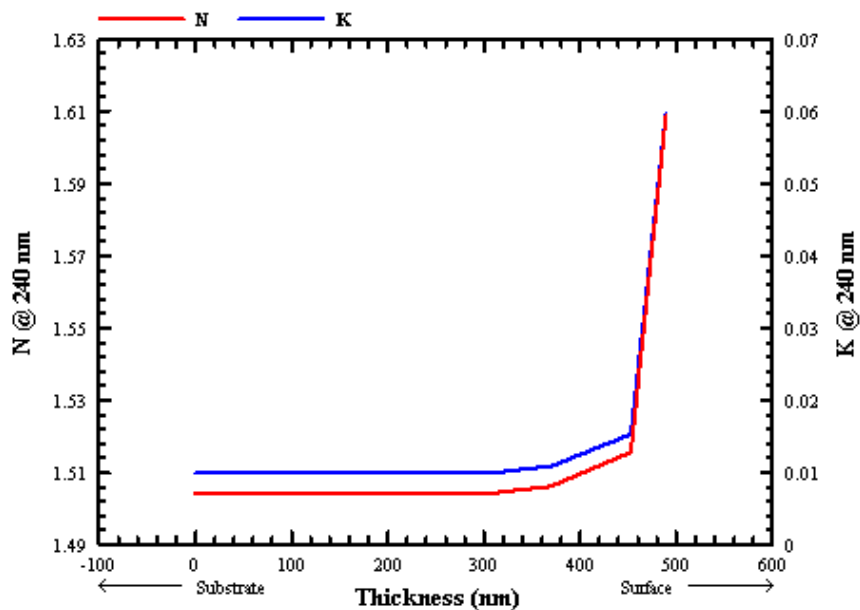
Low-k (As Deposited)



Low-k (Plasma Damaged)



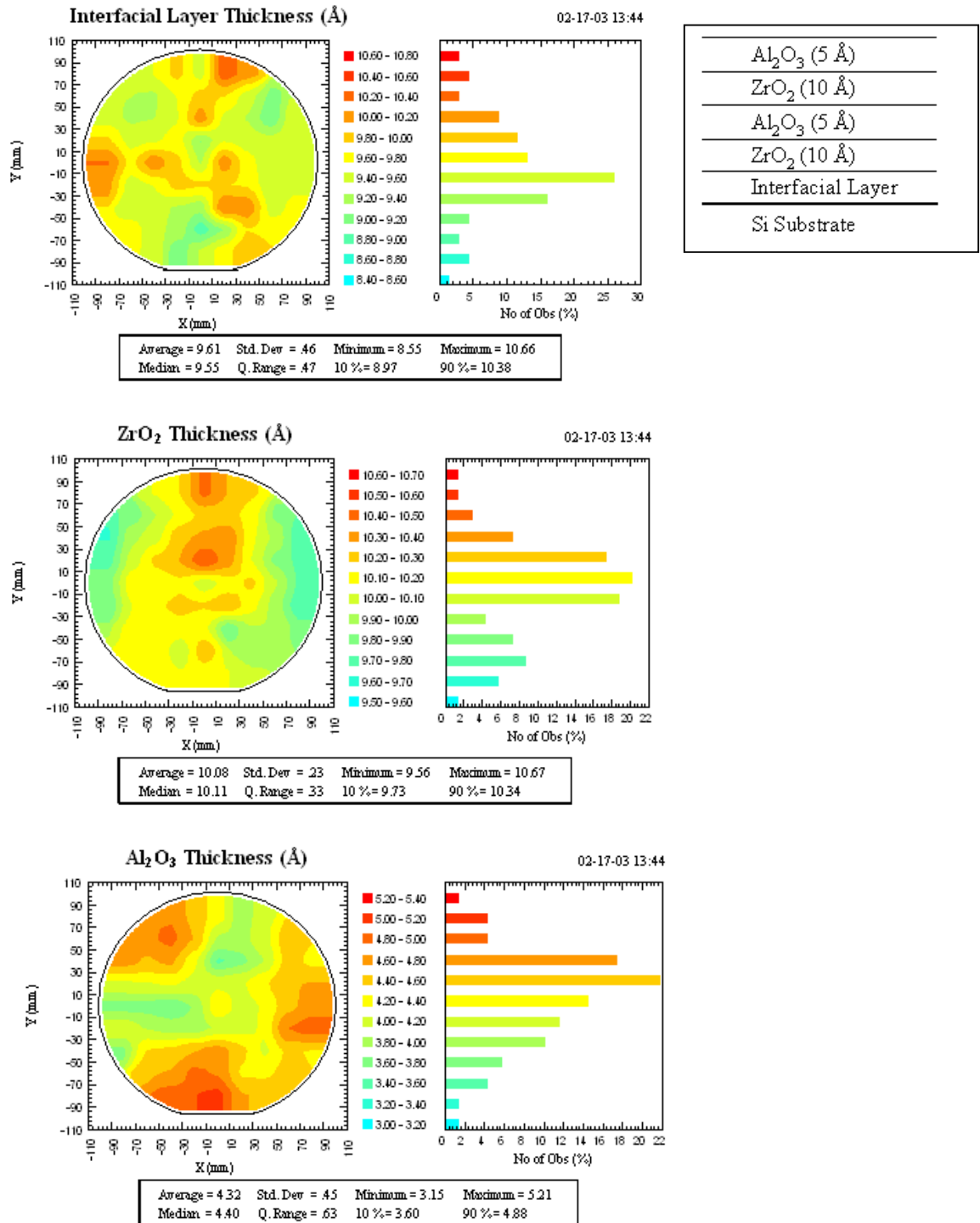
Low-k Plasma Damaged



Characterizing High-k Materials(表现高 K 材料特性)

FilmTek™ Advantages 优势

- Measure multi-layer advanced high-k film stacks with SCI's unique Multi-Angle Differential Polarimetry (MADP) technology.
- Simultaneous determination of the interfacial layer thickness.

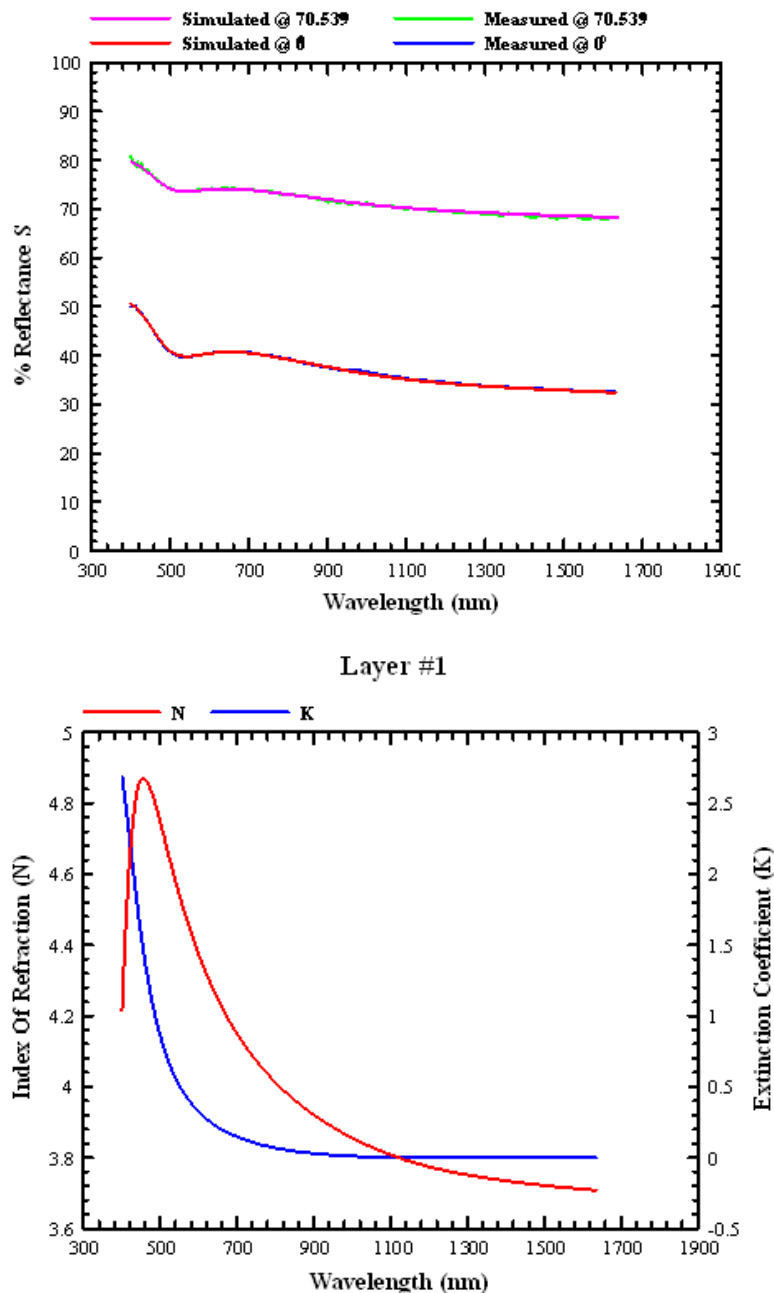


Characterizing SiGe(表现锗化硅特性)

FilmTek™ Advantages 优势

- Simultaneous determination of SiGe thickness and germanium concentration.
- 同时决定锗化硅厚度和锗浓度
- Fast, accurate, and repeatable measurement of thin and thick SiGe films.

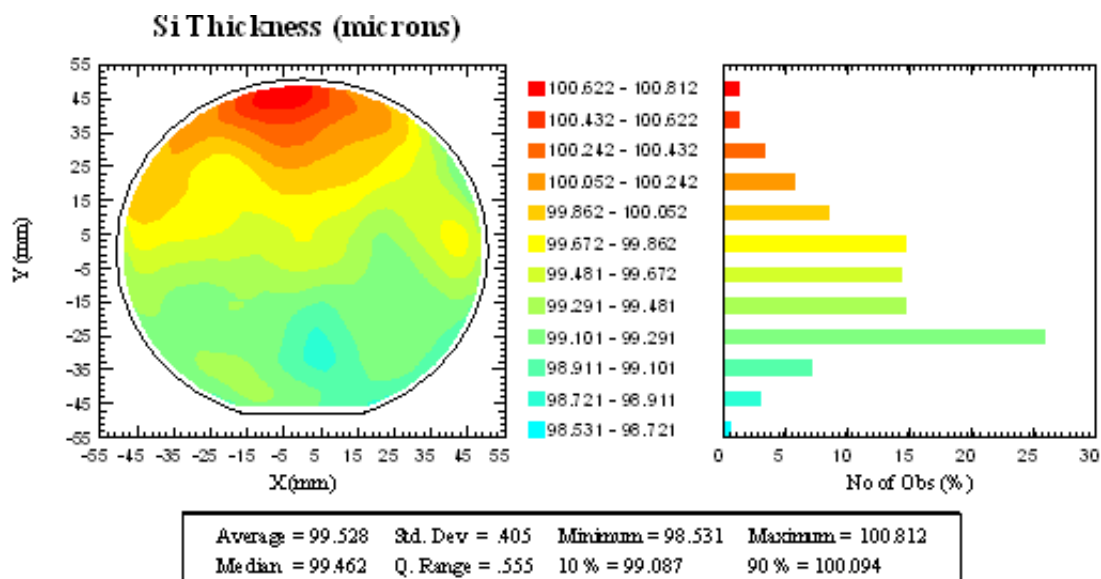
SiGe Thickness = 442.5 Å
% Ge = 35%



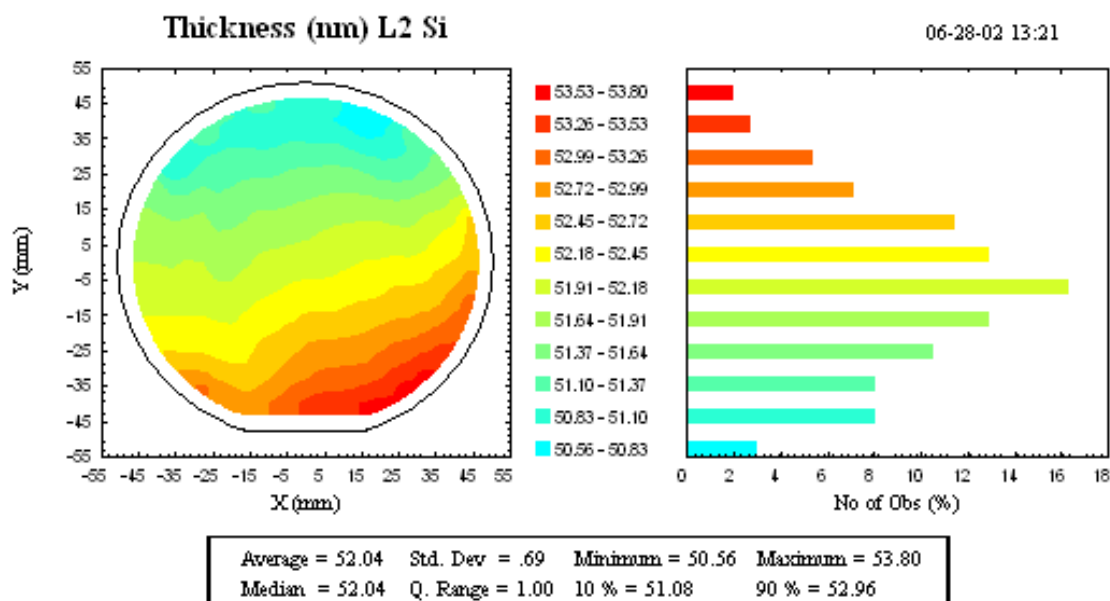
Measuring Silicon-on-Insulator (SOI) Films (测量绝缘体上硅薄膜) FilmTek™ Advantages 优势

- Simultaneous determination of silicon and buried oxide thickness.
- Fast, accurate, and repeatable measurement of thin and thick SOI films.

Thick SOI (100 microns)



Thin SOI (50 nm)



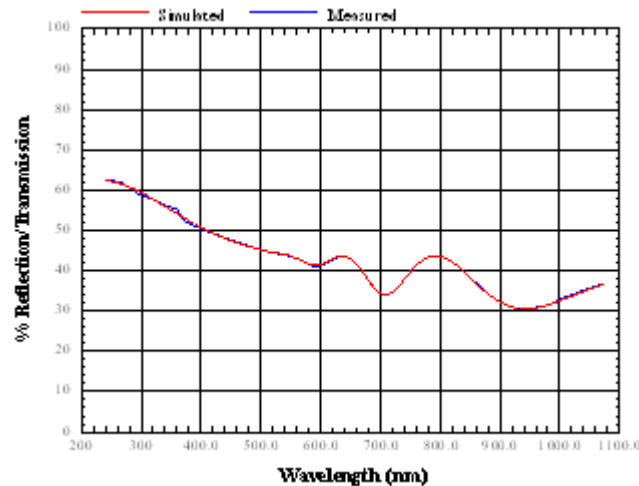
Characterizing Amorphous Silicon and Polysilicon (表现非晶硅和多晶硅特性)

FilmTek™ Advantages 优势

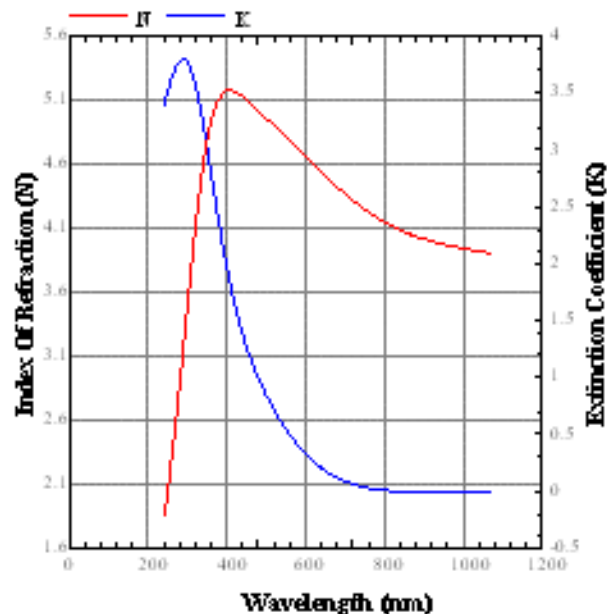
- Simultaneous measurement of a-Si thickness, oxide thickness, and a-Si crystallinity.
- Advanced process control achieved with FilmTek's™ high resolution measurement of optical constants and thickness.

Amorphous Silicon/Oxide/Silicon

a-Si Thickness = 2506.0 Å
Oxide Thickness = 46.0 Å
Crystallinity = 0.5%



NK Spectra of a-Si



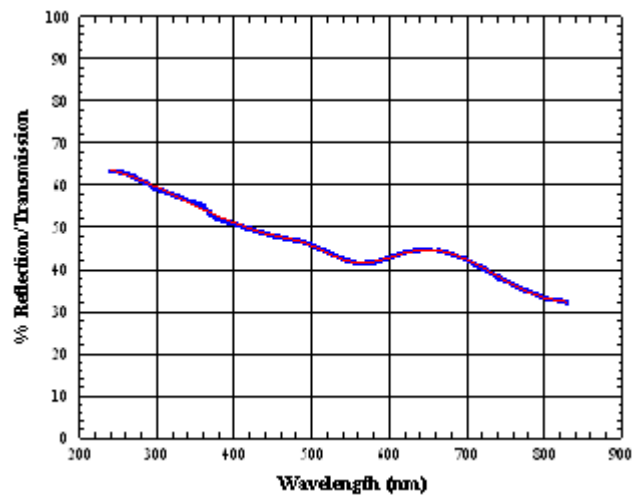
Study of Amorphous Silicon Crystallization Due to Heat Treatment

Sample Number	Hold Time at 550 C (hours)	Thickness (Å) (Main Layer)	% a-Si (Main Layer)	Top a-Si Thickness (Å)
1	0	4191	100	4191
2	6	4004	82.67	51
3	7	4003	61.33	37
4	8	4069	26.70	23
5	10	4102	10.66	14

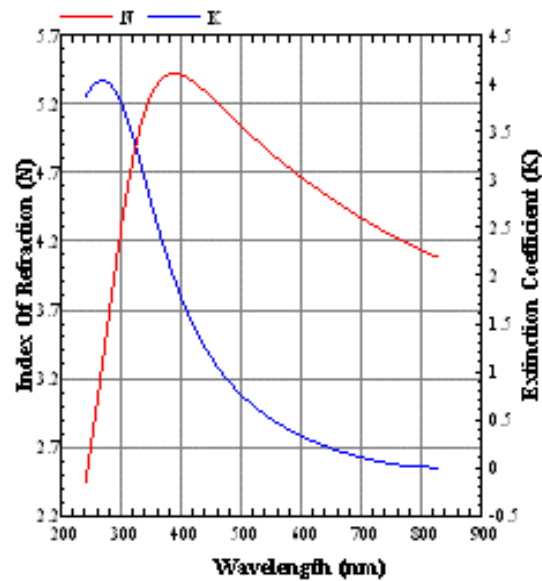
Note: a-Si films deposited on 1000 Å of thermal oxide

Polysilicon/Oxide/Silicon

Poly-Si Thickness = 1114.9 Å
Oxide Thickness = 19.8 Å



NK Spectra of Polysilicon

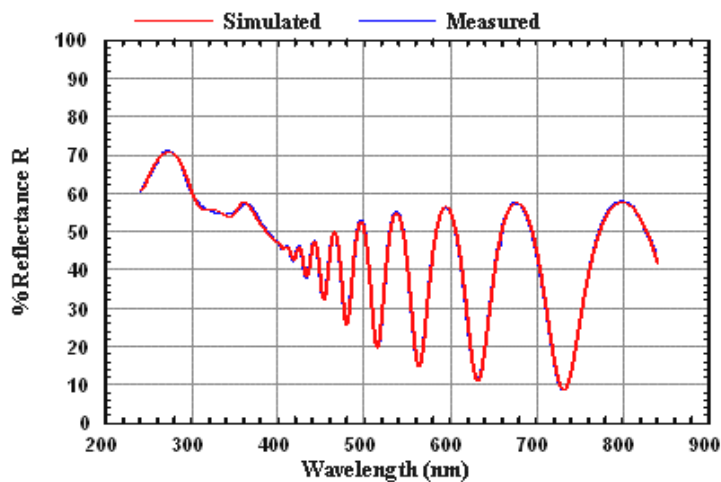


Characterizing Silicon on Sapphire(表现兰宝石上硅特性)

FilmTek™ Advantages

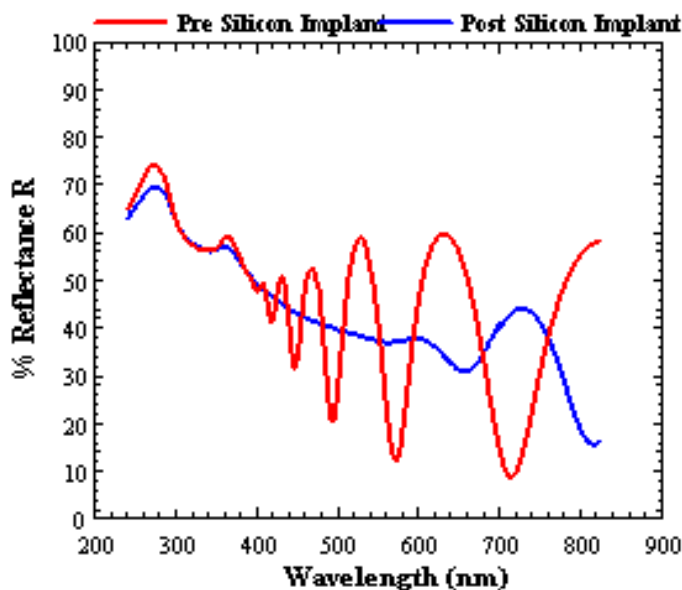
- Simultaneous measurement of silicon thickness and surface roughness.
- 同时测量硅厚度和表面粗糙度
- Measure the profile of silicon implant damage using FilmTek's™ advanced modeling algorithms. 利用 FilmTek's™先进建模算法测量硅植入损伤轮廓
- Superior film characterization enables accurate and repeatable process monitoring.
- 优异薄膜特性表现力使精确和可重复的操作[加工]过程监视成为可能

Heteroepitaxial Silicon on Sapphire 兰宝石上异质硅



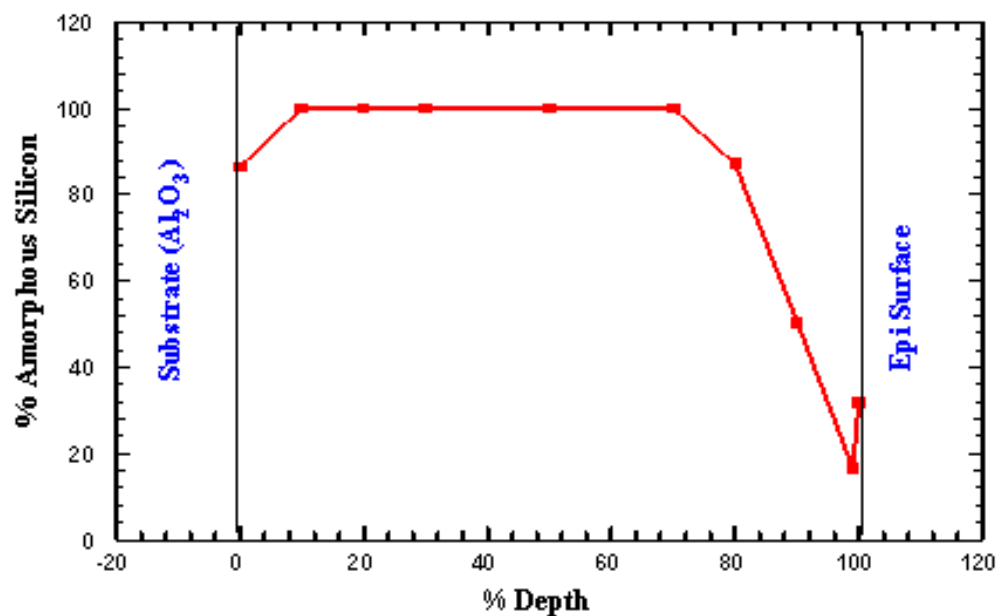
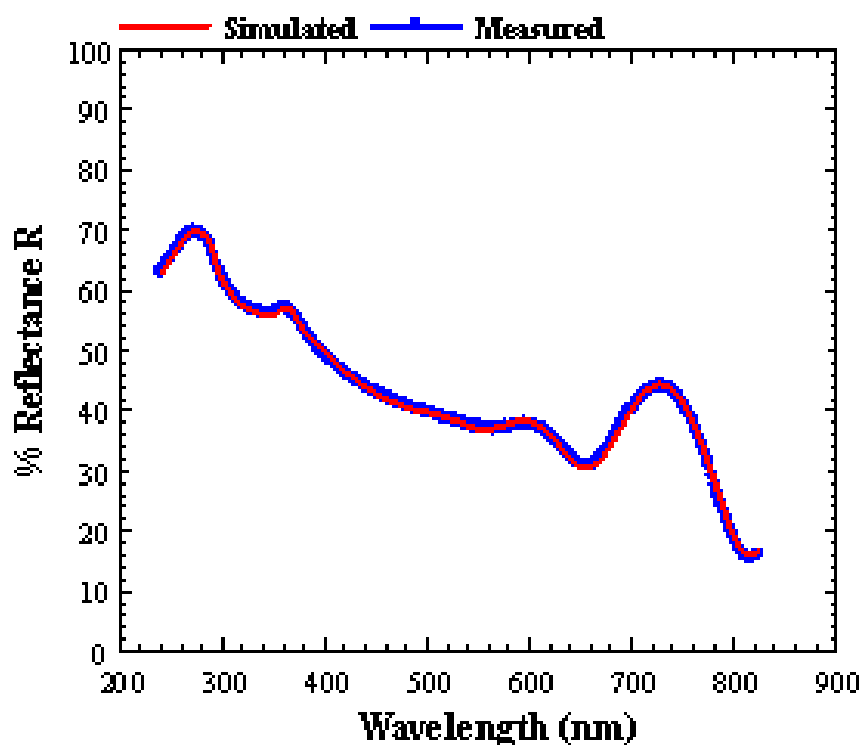
Silicon Thickness = 4987.0 Å
RMS Surface Roughness = 28.0 Å

Profile of Implant Damage: Silicon Epi on Sapphire 植入损伤轮廓: 兰宝石上硅 Epi



280 nm Silicon Epi on Sapphire
Pre and Post Si Implant

280 nm Silicon Epi on Sapphire
Post Si Implant



Characterizing Photomasks(表现光掩模特性)

FilmTek™ Advantages 优势

- FilmTek™ 3000 measures reflection and transmission. 反射和透射测量
- Simultaneously characterize the photoresist, chrome oxide, and chrome layer thickness.
- 同时表现光刻胶, 氧化铬, 铬层厚度的特性

Photoresist/Cr₂O₅/Cr/Quartz Substrate 光刻胶/五氧化二铬/铬/石英衬底

