

## Silicon Substrates

This note contains information related to procedures needed to determine native oxide thickness on silicon. The procedure is similar for other semiconductor substrates.

This information can then be used for subsequent analysis of coated samples using the same substrate.

Ellipsometer types	M-2000, RC2, alpha-SE
Software	CompleteEASE
Typical data required	Standard ellipsometric data at 2-3 angles between 50°-75°
Typical model required	Blank.mod
Considerations	Backside reflections



 Measure sample or open saved data

2. Open "Blank.mod" to start (New versions of CompleteEASE automatically start with this model loaded. If needed, from the Model panel, click 'Open'. Browse the Library tab, Basic folder to find Blank.mod. Click 'Open' to load the model structure into the Model panel.)

 Click on "<u>none</u>" to open material file library

lie Location:	Elles:	
Recent Projects Library	Name	Date Size
Advanced	a-Si on Glass (with Backside Reflection).mod 7/24/1	3 4:49 PM 8 KB
Basic	a-Si on Glass.mod 7/24/1	3 4:50 PM 8 KB
Calibration Wafers	Blank.mod 6/26/0	99:00 AM 0 KB
	Glass Substrate (with backside reflection).mod 7/24/1	3 4:47 PM 4 KB
	Glass Substrate-Transmission Data Included 7/24/1	3 4:45 PM 11 KB
	Glass Substrate-Transmission Data Included 7/24/1	3 4:46 PM 11 KB
	Glass Substrate.mod 7/24/1	3 4:48 PM 4 KB
	Glass with Absorbing Film (with Backside refl 7/24/1	3 4:43 PM 12 KB
	Glass with Absorbing Film.mod 7/24/1	3 4:44 PM 12 KB
	Glass with Transparent Film (with Backside r 7/24/1	3 4:41 PM 5 KB
	Glass with Transparent Film.mod 7/24/1	3 4:42 PM 5 KB
	ITO (thin) on Glass (with backside reflection) 6/22/0	3 12:58 PM 3 KB
	ITO (thin) on Glass.mod 7/22/0	3 10:54 AM 3 KB
	ITO on Glass (with Backside reflection).mod 6/22/0	3 12:58 PM 3 KB
	ITO on Glass.mod 7/22/0	3 10:55 AM 3 KB
	Si with Absorbing Film.mod 7/24/1	3 4:40 PM 20 KB
	Si with Native Oxide.mod 7/22/0	3 10:55 AM 1 KB
	Si with Thermal Oxide XNIR.mod 6/16/1	78:47 AM 189 KB
	Si with Thermal Oxide.mod 7/22/0	3 10:55 AM 1 KB
	Si with Transparent Film.mod 7/24/1	3 4:38 PM 13 KB
	\$	
File <u>N</u> ame:  Blank.r	nod	
Comment: Blanks	Starting Model	
	Open Cancel	

Substrate = none

- Browse Library tab, Semiconductor folder to find si\_jaw.mat
- Click "Open" to add the material file to the model structure

ile Location:	<u>F</u> iles:		
Recent Projects Library	Name	Date	Size
Advanced	Poly-Silicon C (Comp Library).mat	3/24/97 9:32 AM	11 KB
Ravia	Poly-Silicon N (Comp Library).mat	7/25/97 5:18 PM	16 KB
Dielectric	PZT film.mat	10/15/93 4:56 AM	1 KB
Evamples	Se E.mat	2/7/92 5:45 PM	0 KB
Matal	Se O.mat	2/7/92 5:42 PM	0 KB
Semiconductor	Si Aspnes.mat	10/19/94 7:04 PM	4 KB
	Si Jellison.mat	7/10/97 5:54 PM	6 KB
	Si NIST.mat	3/31/98 2:43 PM	0 KB
	Si Temp (Temp Library).mat	12/23/97 1:34 PM	6 KB
	Si Temp JAW (Temp Library).mat	8/1/05 4:24 PM	13 KB
	Si Temp LI (Temp Library).mat	12/23/97 1:42 PM	4 KB
	Si VUV.mat	10/1/02 4:11 PM	2 KB
	Si.mat	10/19/94 7:05 PM	5 KB
	Si_JAW.mat	3/31/98 2:29 PM	14 KB
	Si_JAW2.mat	4/2/10 9:46 AM	135 KB
	si_noc.mat	12/5/17 12:28 PM	279 KB
	Si_Temp_JAW(-25_500C).mat	2/19/18 12:21 PM	40 KB
	SiC 4H E.mat	1/30/03 10:54 AM	7 KB
	SiC 4H O.mat	1/30/03 10:54 AM	7 KB
	SiC.mat	2/7/92 5:21 PM	1 KB
File Name: SLJAW.mat Si substrate, Hera analysis)	inger et.al., JAP v63p3323y1998, (multi-waveler	ngth, multi-sample	



- Click the Layer Command "<u>Add</u>" to add layer(s)
- Use mouse to position blue bar above substrate and click once
- Browse Library tab, Semiconductor folder to find ntve\_jaw.mat
- 9. Click "Open" to add material to model structure
- Right-click "0.00nm" to make the native oxide thickness a fit parameter

Layer Commands: Add Delete Save Include Surface Roughness = OFF Substrate = Si\_JAW 🔗 Add Layer To Model Layer Type Substrate = : Si\_JAW Standard Intermix Cancel A Open File Location: Files Date 2 KB 10/19/94 6:10 PM 2 KB 10/19/94 7:00 PM 5 KB 10/19/94 7:03 PM 2 KB Recent Projects Library Name InP Oxide.ma Advanced Basic Dielectric InP.mat InSb 2.mat InSb.mat 10/19/94 7:03 PM 5 KB Examples INTR\_JAW.MAT INTR\_JAW2.mat intr\_noc.mat INTR\_NST.MAT 3/31/98 2:34 PM 9/15/11 11:43 AM 12/5/17 12:29 PM 3/31/98 2:47 PM 9 KB Metal Semiconductor 587 KB 260 KB 0 KB MCT (Comp Library), mat 3/24/92 9:47 AM 41 KB MCT (Comp Library).mat MCT 2 (Comp Library).mat NTVE\_JAW2.mat ntve\_noc.mat 10/19/94 6:40 PM 39 KB 
 3/31/98 2:43 PM
 4 KB

 9/15/11 11:45 AM
 601 K

 1/5/18 1:53 PM
 260 K

 1/2/24/91 11:29 AM
 1 KB
4 KB 601 KB 260 KB PbS.mat PbSe.mat 2/7/92 5:51 PM 0 KB PbTe.mat Poly-Ge\_g.mat poly-Si\_annealed\_McGahan\_comp.mat 2/7/92 5:52 PM 10/5/11 4:32 PM 11/23/09 4:57 PM 10/5/11 4:36 PM 0 KB 0 KB 16 KB Poly-Si\_g.mat 0 KB Poly-Si\_g2.mat 10/5/11 4:38 PM 0 KB File Name: NTVE\_JAW.MAT Comment Native Si oxide, Herzinger et.al., JAP v83p3323y1998, (multi-wavelength, multi-sample analysis) Open Cancel Layer # 1 = <u>NTVE\_JAW</u> Thickness # 1 = <u>0.00 nm</u> Substrate = Si JAW Layer # 1 = <u>NTVE\_JAW</u> Thickness # 1 = <u>0.00 nm</u> (fit) Substrate = Si\_JAW



11. From the Fit panel, click'Fit'

## 12. Evaluate result by considering:

- Do the model generated curves visually match the experimental curves?
- What is the MSE value?
- Is the native oxide thickness result physically reasonable?

CompleteEASE	- 0 ×
Measurement I a situ Analysis Hardware Ontions	
Measurement in situ Analysis Hardware Options	
Data: 1-1_Bare Si Wafer Model: Blank (Blank Starting Model)	
Qpen Save Info. Set Ranges Open Save Clear Snapshot S	ave Snapshot
Fit: Layer Commands: Add Delete Save	
Generate Eit Fit Dynamic Reset Include Surface Roughness = OFF	
Layer # 1 = <u>NTVE_JAW</u> Thickness # 1 = <u>1.67</u>	<u>nm</u> (fit)
Thickness # 1 = 1.67±0.001 nm	
MODEL Options	
+ FIT Options	
+ O IHER Options	
Turn Off All Fit Parameters	
*	
Data Model Results	Show Data
Variable Angle Spectroscopic Ellipsometric (VASE) Data	
50	)
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40 Psi (55.00, 60.00, 65.00, 70.00, 75.00, 80.00°)	]
Model	
30	<b>65</b>
2 30 2 30 90	Delta
20 90 90	Delta
	Delta
	Delta
	Delta
	Delta
30 20 10 0 0 300 600 900 1200 1500 1800 800 800 800 800 800 800 800 800	Delta

 If the result is acceptable, save the model with a unique name for subsequent analysis of coatings on same or similar substrates

(From model panel, click 'Save'. Use Recent or Projects tab to locate desired folder.)

🚱 Save			×
File Location:	<u>F</u> iles:		
Recent Projects Library	Name	Date	Size
Common (C1CompleteEASE)			
File <u>N</u> ame:			
Comment:			
	Save Cancel		



## **Backside reflections**

If substrate is double side polished, reflections from the substrate backside may be present in the data.

Backside reflections will cause a step in the data near the substrate material's bandgap. Detection of these reflections will depend on the spectral range of your ellipsometer.

When this occurs, you can exclude this region from your analysis or account for backside reflections in your model.

To include this effect in your model, expand +MODEL Options, turn ON "Include Substrate Backside Correction", and enter substrate thickness into the model.



Layer Commands: Add Delete Save Include Surface Roughness = <u>OFF</u> Layer # 1 = <u>NTVE\_JAW</u> Thickness # 1 = <u>1.67 nm</u> (fit) Substrate = <u>Si\_JAW</u> Substrate Thickness = <u>0.5000 mm</u>

- MODEL Options

Angle Offset = 0.00 Include Substrate Backside Correction = <u>ON</u> Transmission SE Data = <u>OFF</u> Reverse Direction = <u>OFF</u> # Back Reflections = <u>5.000</u> % 1st Reflection = <u>100.00</u> Model Calculation = <u>Ideal</u>

- + FIT Options
- + OTHER Options Configure Options Turn Off All Fit Parameters

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