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FilmTek™

Raising Thin Film Metrology Performance to a New Level

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Through Silicon Via (TSV) Metrology

FilmTek™ TSV Metrology Advantages

- ☑ Measure high aspect ratio TSV structures (up to 30:1)
- ☑ Measure TSV etch depth up to 500µm
- ☑ Measure TSV structures with diameter down to 1µm
- ☑ TSV diameter 1-500 µm
  - CD, 1σ < 0.2%
- ☑ Via depth 0-500 µm
  - Via depth, 1σ < 0.005%
- ☑ Film thickness
  - 10nm-350µm, 1σ < 0.005%
- ☑ 300mm fully automatic measurement (Brooks or SCI automation)
- ☑ Measurement time
  - 1-2 seconds per point

FilmTek™ 2000M

Critical Dimension, Etch Depth, and Film Thickness of TSV Structures

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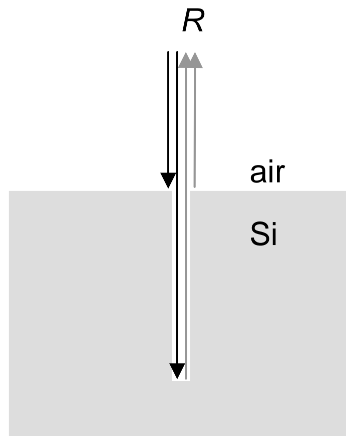
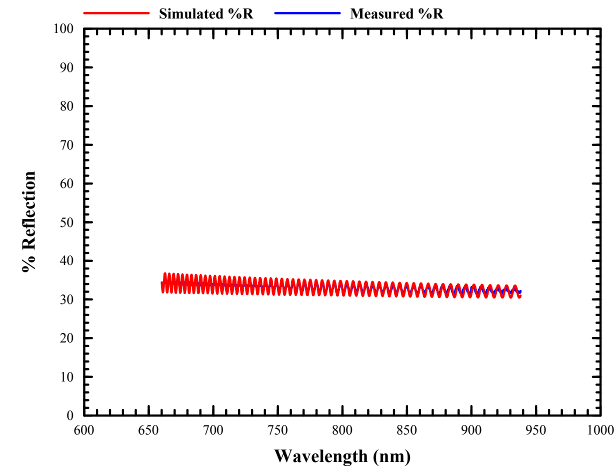
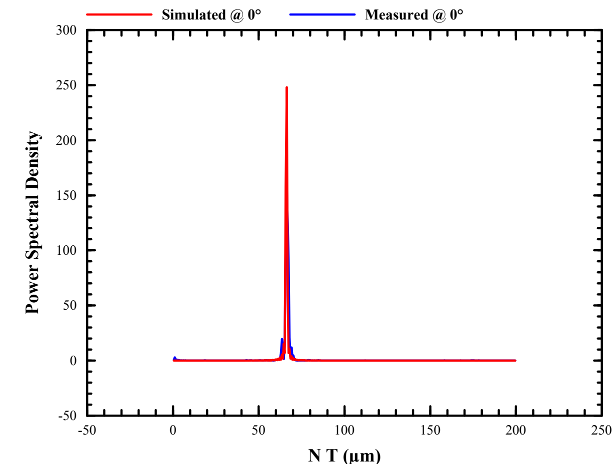
FilmTek^{TM} 2000M TSV Metrology

Optical Etch Depth Measurement of High Aspect Ratio TSV Structures







- Interference between reflected waves is caused by optical path length difference between the top and bottom surfaces of the TSV structure
- The spot size must be small (same order as via diameter) and the measurement beam must be nearly collimated to observe interference in the reflected light

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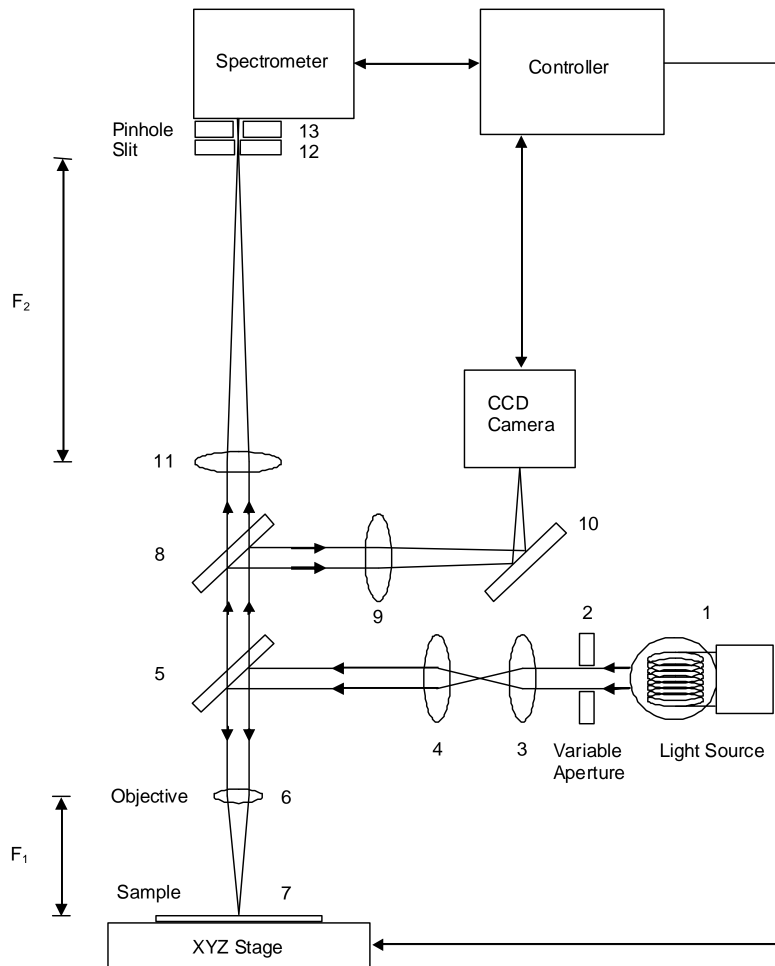
FilmTek™ 2000M TSV Metrology

Patented FilmTek™ Technology



- Variable aperture controls angular spectrum of the incident light
- Measurement spot size and angular spread is proportional to the ratio of F_1 and F_2
- Small measurement spot size is achieved without the use of a high power objective

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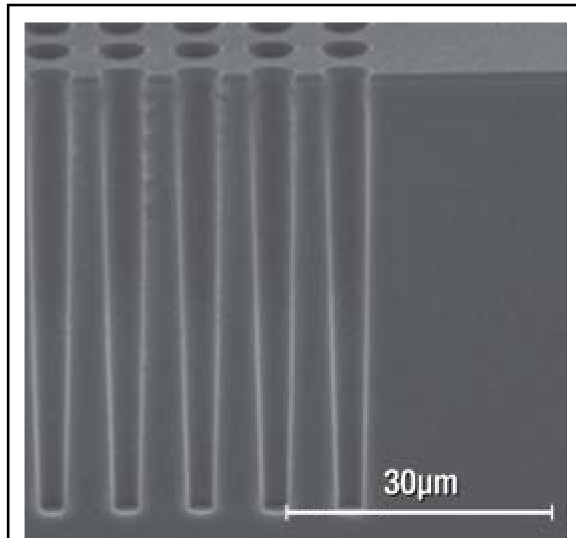
FilmTek™ 2000M TSV Case Study

Comparison of Via Etch Depth by FilmTek™ 2000M and SEM



- Target via depth ≈ 60 μm

Via Diameter (μm)	Etch Depth (μm) SEM	Etch Depth (μm) FilmTek™ 2000M
5	44.5	44.3
10	55.5	55.5
15	62.0	61.8
20	66.5	66.8

- **Excellent agreement between FilmTek™ 2000M and SEM data**

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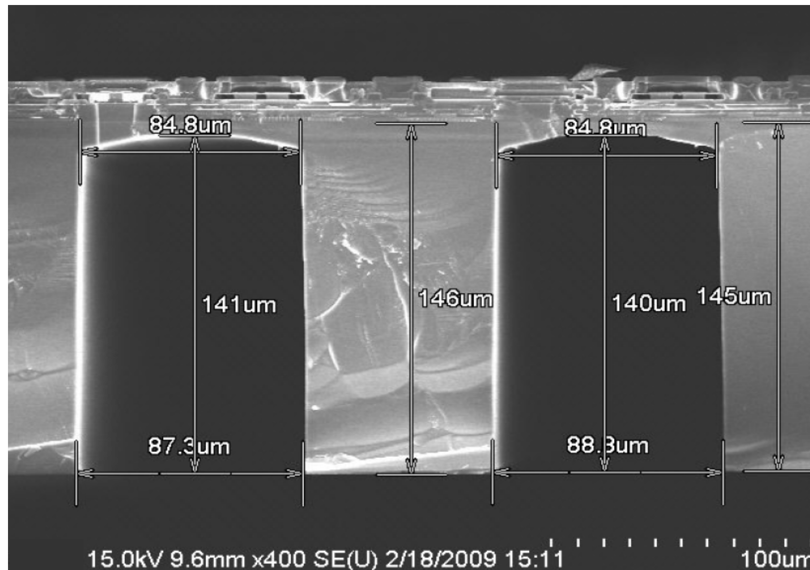
FilmTek™ 2000M Case Study

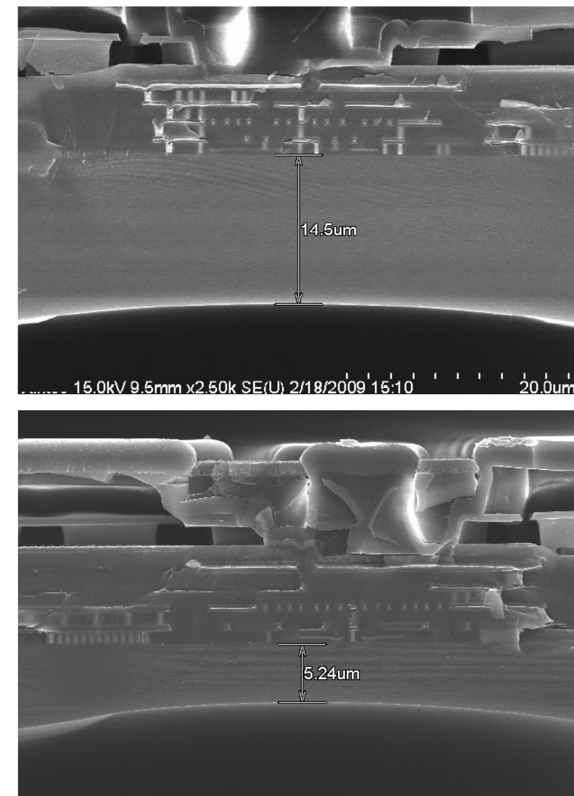
Critical dimension (CD), etch depth, and residual Si thickness measurement

Via structure and dimensions for MEMS application



- Via width ≈ **87 µm**
- Via depth ≈ **140 µm**
- Residual silicon thickness ≈ **10 µm**

Residual silicon thickness



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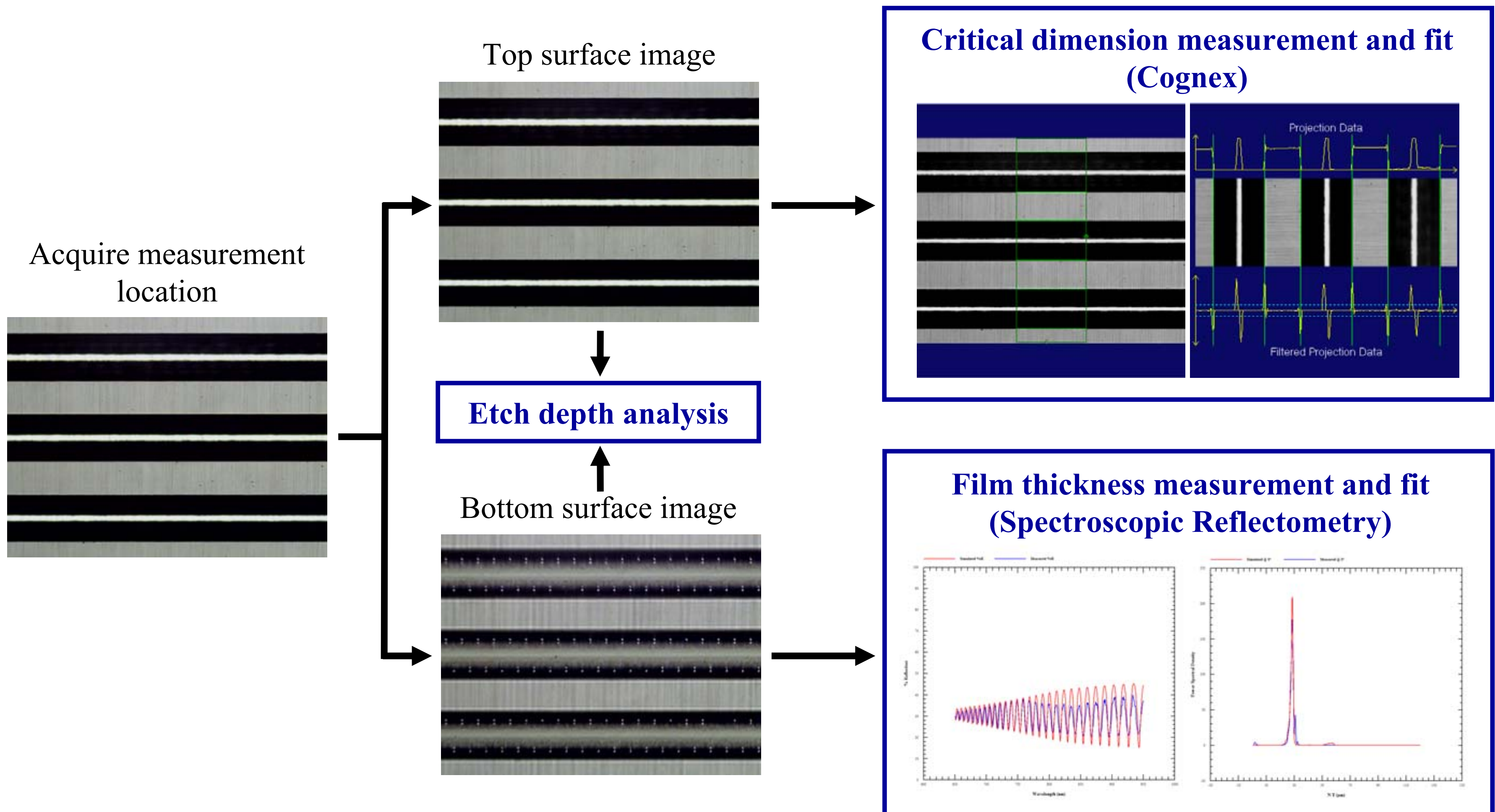
FilmTek™ 2000M Metrology

FilmTek™ 2000M Measurement Sequence



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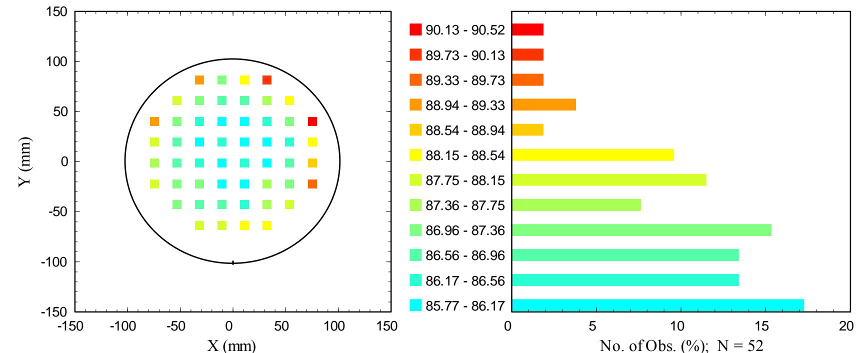
FilmTek™ 2000M TSV Metrology

☑ Fully automated TSV measurements provided to SEMI standard SECS/GEM interface

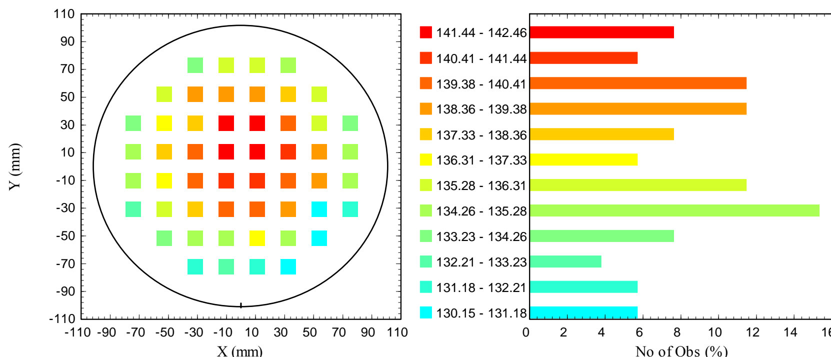
- Etch Depth
- Critical Dimension (CD)
- Film Thickness

Critical Dimension (µm)



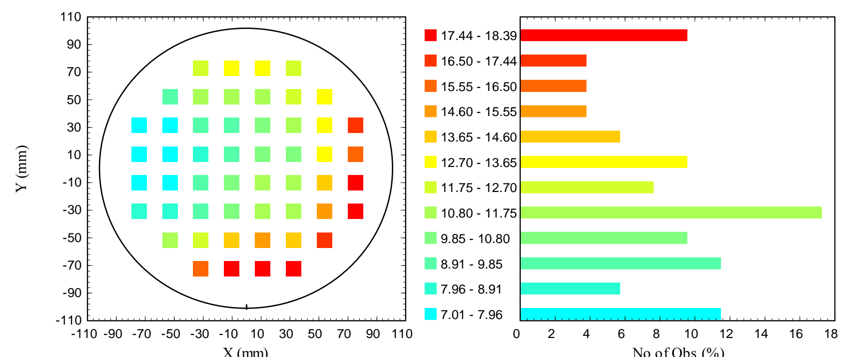
Average = 87.27 Std. Dev = 1.12 Minimum = 85.77 Maximum = 90.52
Median = 87.09 Uniformity = 2.69% 10 % = 85.91 90 % = 88.57

Etch Depth (µm)



Average = 136.63 Std. Dev = 3.35 Minimum = 130.15 Maximum = 142.46
Median = 136.29 Q. Range = 4.71 10 % = 131.63 90 % = 141.42

Silicon Thickness (µm)



Average = 11.93 Std. Dev = 3.23 Minimum = 7.01 Maximum = 18.39
Median = 11.36 Q. Range = 4.60 10 % = 7.71 90 % = 17.38

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FilmTek™ 2000M TSV Case Study

Comparison of FilmTek™ 2000M, SEM, and Zygo Measurements

Sample		SEM			FilmTek™ 2000M			Difference		
Wafer ID	Reticle	Si thickness	Etch depth	CD	Si thickness	Etch depth	CD	Si thickness	Etch depth	CD
#16	R13	18.3	125	89	18.96	124.46	89.30	-0.65	0.54	-0.30
	R83	8.2	123	88	8.57	123.93	88.46	-0.37	-0.93	-0.46
#18	R13	11.6	126	89	11.59	126.58	88.72	0.01	-0.58	0.28
	R58	8.9	126	87	8.75	126.79	86.57	0.15	-0.79	0.43

Sample		Zygo NV7300		FilmTek™ 2000M		Difference	
Wafer ID	Reticle	Si thickness	Etch depth	Si thickness	Etch depth	Si thickness	Etch depth
#16	R45	NA	136.28	10.77	136.54	NA	-0.26
	R61	NA	126.24	16.61	125.91	NA	0.33
#18	R45	NA	136.32	11.15	136.67	NA	-0.35
	R61	NA	128.15	16.72	127.90	NA	0.25

- Excellent agreement between FilmTek™ 2000M, SEM, and Zygo data

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FilmTek™ 2000M TSV Metrology

FilmTek™ 2000M TSV Performance Specifications

Measurement Functions	Critical Dimension (CD), Etch Depth, Film Thickness
Wafer Handling	Brooks or SCI Automation
Substrate Size	200/300mm
Pattern Recognition	Cognex
CD Precision (1σ)	< 0.2%
Etch Depth Precision (1σ)	< 0.005%
Film Thickness Range	10nm – 350 µm
Film Thickness Precision (1σ)	< 0.005%
Light Source	Halogen Lamp
Reflection Wavelength Range	380-1000nm
Detector Type	3648 pixel silicon CCD array
Wafer Throughput, 9 sites	> 60 WPH

FilmTek™ 2000M

Critical dimension, etch depth, and film thickness for Through Silicon Via (TSV) metrology