

ULTRATHIN Ru THICKNESS MEASUREMENT



FEOL WAFER PROCESSING / BLANKET WAFER

INTRODUCTION

Thin film monitoring is an integral part of the applications portfolio of the Onyx 3000. Using small-spot EDXRF, ultrathin films are measurable independent of their physical properties, such as transparency or opaqueness. Optical measurement techniques are affected by surface roughness (that reduces measured intensity) and by optical parameters that change as film thickness decreases; EDXRF is unaffected.

MEASUREMENT OBJECTIVE

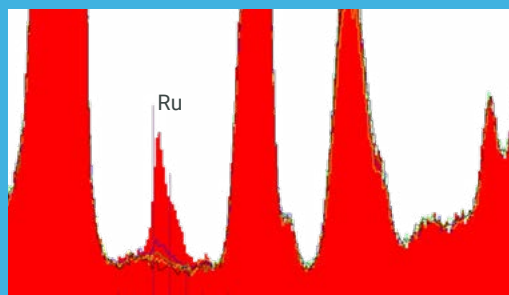
Measure five wafers with different Ru film thickness.

Test 1: thickness results on nine defined points

Test 2: static test on four defined points (15 times each)

Defined objectives:

- Measure test 1 and 2 with 60-second acquisition time
- Required TPT <13 minutes per wafer (for 10 sites)
- Required precision <0.2 Å standard deviation



■ 10 Å ■ 2 Å ■ 1 Å ■ 0.7 Å ■ 0 Å

STACK STRUCTURE

Ru	≤10 Å
SiO ₂	50 Å
Si-Sub	

REPEATABILITY

Four sites were measured with 60-seconds acquisition time, 15 times each, removing the wafer after each measurement. In the first table, the thickness values are presented, and the standard deviation of each site is given in the second table.

THICKNESS [Å]

Site/Slot	21	22	23	24	25
(0,0)	0.134	0.744	1.232	1.784	9.784
(0,65)	-0.141	0.720	1.208	2.141	9.873
(65,0)	0.169	0.697	1.185	2.034	9.364
(0,-65)	0.153	0.657	0.875	2.087	10.038
(-65,0)	0.098	0.877	1.165	2.034	10.142
(0,130)	-0.116	0.646	1.154	2.195	9.903
(130,0)	-0.152	0.716	0.904	2.034	10.007
(0,-130)	0.163	0.590	1.084	1.909	9.664
(-130,0)	-0.149	0.726	0.854	1.801	9.560

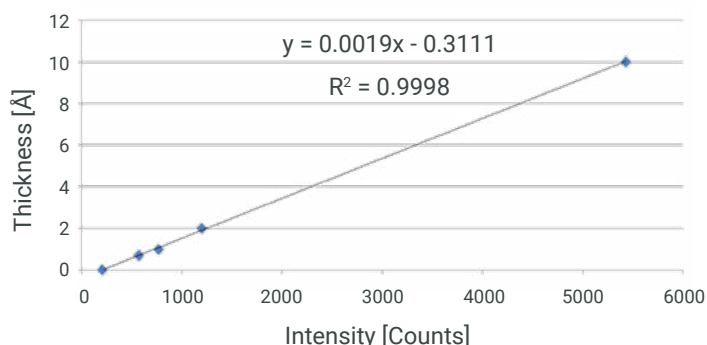
THICKNESS [Å]

Site/Slot	21	22	23	24	25
(0,30)	0.112	0.687	1.069	1.888	9.927
(0,-30)	0.082	0.742	1.051	1.987	9.254
(30,0)	0.139	0.622	0.989	1.833	9.586
(30,0)	0.198	0.801	1.369	1.658	9.102

STANDARD DEVIATION [Å]

Site/Slot	21	22	23	24	25
(0,30)	0.491	0.264	0.168	0.112	0.068
(0,-30)	0.513	0.282	0.185	0.104	0.058
(30,0)	0.527	0.303	0.211	0.107	0.054
(30,0)	0.615	0.278	0.157	0.098	0.047

CALIBRATION CURVE USING THE GIVEN WAFERS



Calibration curve was set per the demo wafers with the nominal values.

SUMMARY

- The Onyx 3000 can measure ultrathin films with high precision.
- For this application, the XRF precision of the Onyx 3000 is <math><0.2 \text{ \AA}</math> for Ru films 1 Å and above.
- The throughput for nine sites is <math><13</math> minutes.