I A S

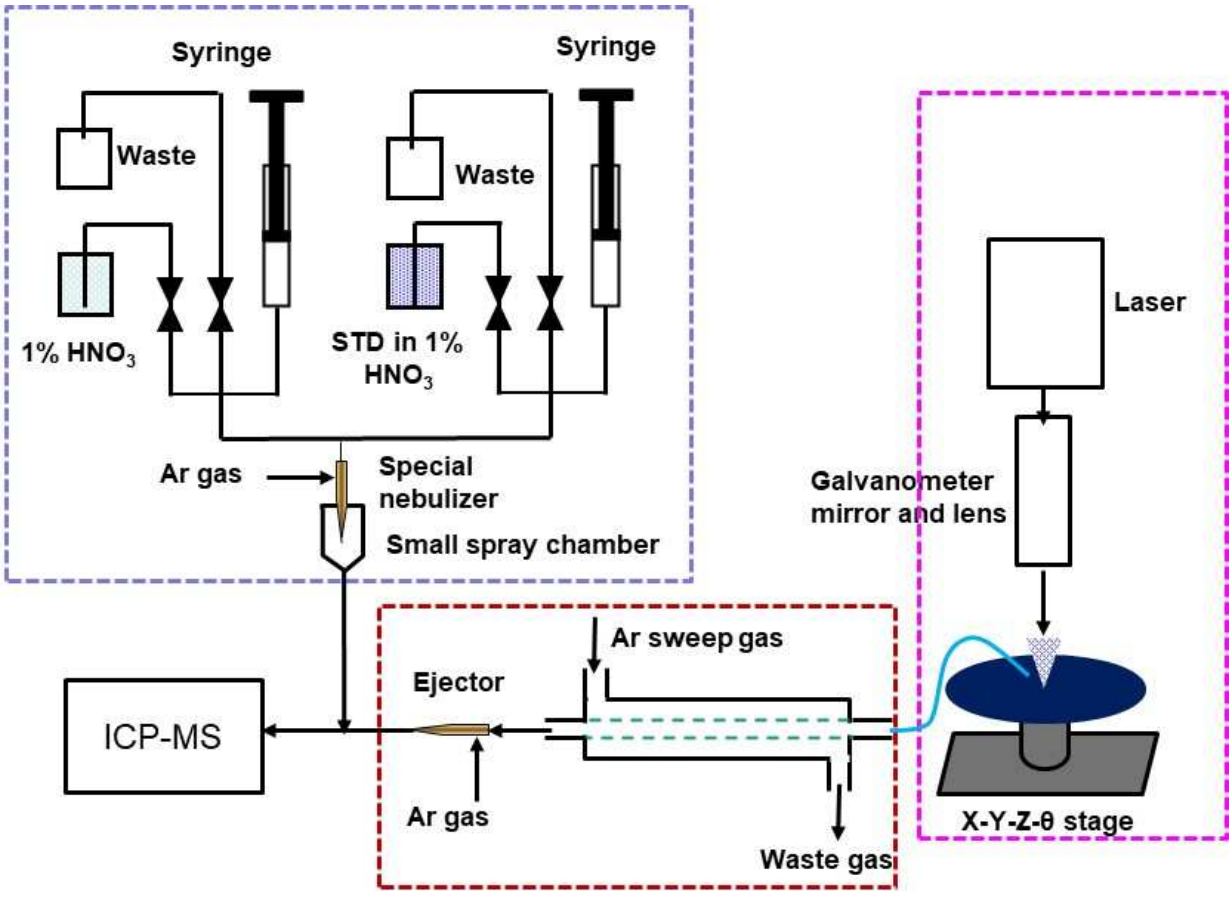
LAGM
Laser Ablation
GED_MSAG System

IAS Inc.

A 300 mm wafer sample can be analyzed by Laser Ablation (LA) ICP-MS without using a small, enclosed cell. Generated particles by LA are aspirated by an ejector and introduced to ICP-MS via GED.

Features

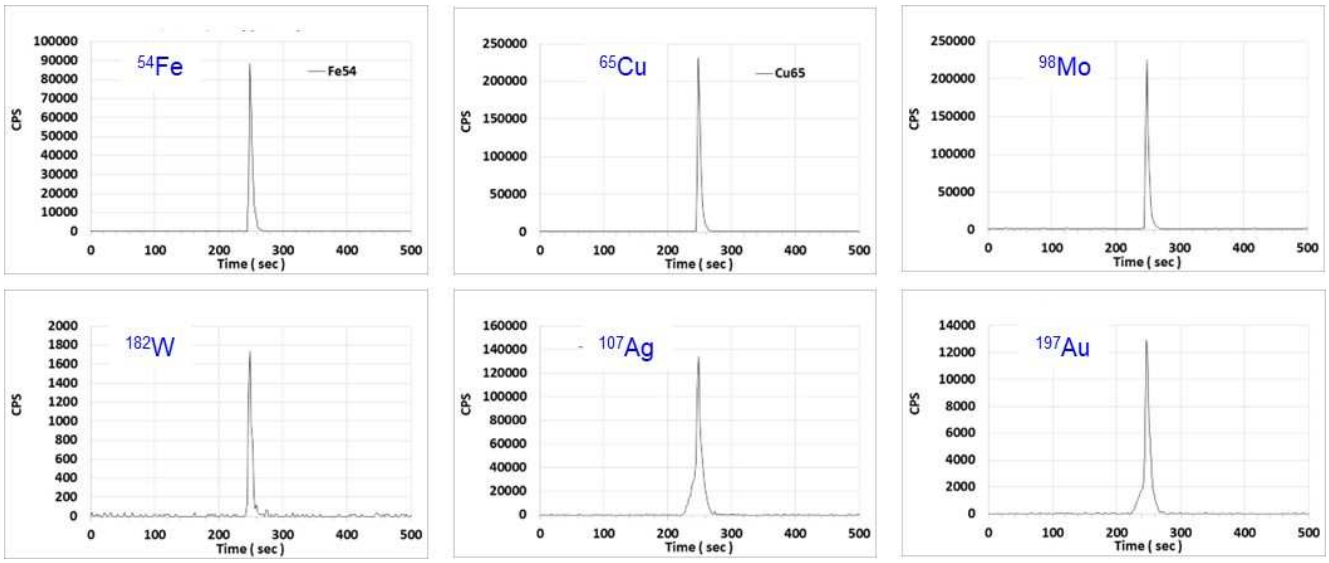
- Femto-second laser and Galvanometer mirror ablates up to 12” (300 mm) wafer precisely.
- A wafer sample is laser ablated without using a small, enclosed cell, and the generated particles are aspirated by the ejector and introduced to the ICP-MS via Gas Exchange Device (GED).
- Dual syringe model MSAG_DS enables quantitative analysis under a dry plasma condition of ICP-MS using the method of standard addition.
- Ultra-trace level of spot and wafer bevel analysis is available.
- Deeper level, > 300 µm, of profile and impurity analysis is available.
- Two load ports from 12“ (300 mm) to 6” (150 mm) wafer, aligner and wafer transfer robot are integrated for fully automated operation (Option)
- Alternative sampling stage is available for non-wafer samplers.



Schematic diagram of LA-GED-MSAG-ICP-MS

Analysis of spiked Si wafer

- TRA analysis of spiked Si wafer sample
- 5 uL of 0.1 ppb mixed standard was spiked on a Si wafer and dried.



LA frequency : 10 kHz, Galvanometer mirror scan speed : 50 mm/sec, Galvanometer mirror scan width : 5 mm (Y axis direction),
Wafer stage movement speed : 0.0476 mm/sec (X axis), Wafer stage movement distance : 40 mm (X axis)
ICP-MS data acquisition mode : Transient analysis, Dwell time : 50 msec/mass, Date acquisition interval : 1.62 sec

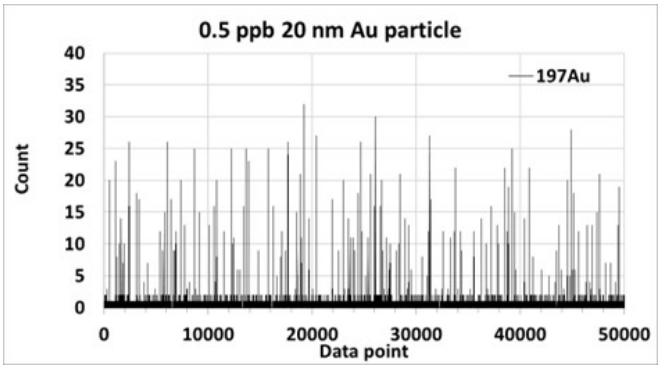
- Quantitative analysis of SiC wafer using the method of standard addition

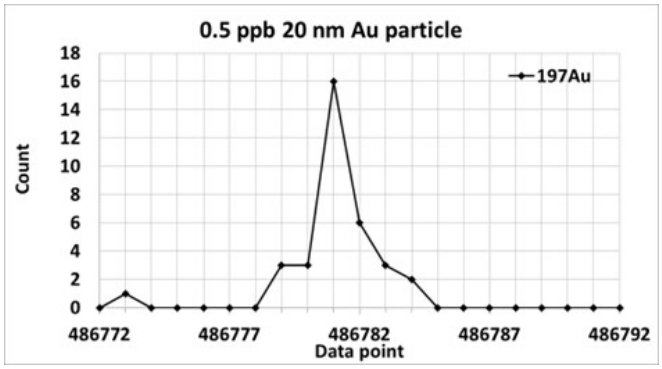
Analyte	Mass	Ar						SiC						Subtraction (ag)	Conc. (wt. ppb)
		MSAG 10 ppb STD flow (uL/min)			Corr.	ag/count	ag	MSAG 10 ppb STD flow (uL/min)			Corr.	ag/count	ag		
		0	1.5	3				0	1.5	3					
Li	7	16	174,989	367,620	1.000	1.4	22	12	176,033	367,165	1.000	1.4	16	(6)	< 51
Na	23	267	259,241	501,581	1.000	1.0	267	154	259,383	496,774	1.000	1.0	155	(111)	< 137
Mg	24	3	36,759	76,255	1.000	6.6	18	30	42,229	77,791	0.999	6.4	195	177	**647**
Al	27	469	196,939	400,024	1.000	1.3	587	4,853	196,846	398,317	1.000	1.3	6167	5581	**20,400**
K	39	855	89,725	193,945	0.999	2.6	2214	848	88,370	196,667	0.998	2.6	2165	(49)	< 814
Ca	40	12	77,147	165,683	0.999	3.0	37	6,095	78,132	171,641	0.997	3.0	18409	18372	**67,000**
Ti	48	4	3,684	7,533	1.000	66.4	266	30	4,401	7,658	0.996	65.5	1988	1723	**6,280**
V	51	7	42,665	93,469	0.999	5.3	37	9	42,062	96,303	0.997	5.2	48	11	< 174
Cr	52	2,184	98,824	204,904	1.000	2.5	5386	2,301	97,829	209,541	0.999	2.4	5551	165	< 1270
Mn	55	241	195,973	406,693	1.000	1.2	297	149	193,386	417,034	0.999	1.2	179	(118)	< 160
Fe	56	508	158,139	333,800	1.000	1.5	762	4,205	210,726	347,230	0.993	1.5	6130	5368	**19,600**
Fe	54	113	12,092	25,652	0.999	19.6	2212	282	14,793	26,556	0.998	19.0	5373	3161	**11,500**
Co	59	28	112,862	243,015	0.999	2.1	58	24	111,429	248,375	0.998	2.0	48	(9)	< 108
Ni	60	77	27,434	58,610	0.999	8.5	655	93	27,154	60,136	0.998	8.3	772	116	< 877
Cu	63	649	78,263	165,413	0.999	3.0	1970	986	77,793	170,014	0.999	3.0	2917	946	**3,450**
Cu	65	304	35,324	75,103	0.999	6.7	2032	470	34,998	76,734	0.999	6.6	3084	1052	**3,840**
Zn	66	32	34,001	71,822	1.000	7.0	221	148	34,091	73,350	0.999	6.8	1009	788	**2,870**
Zn	64	12	54,735	115,774	1.000	4.3	52	191	54,951	119,118	0.999	4.2	804	753	**2,750**
Ga	71	508	127,800	266,371	1.000	1.9	955	555	130,726	271,534	1.000	1.8	1024	69	< 476
Ge	74	10	5,030	10,857	0.999	46.1	475	12	5,184	10,817	1.000	46.3	540	65	< 1,730
As	75	72	18,006	36,732	1.000	13.6	978	70	17,893	36,577	1.000	13.7	959	(19)	< 1,250
Rb	85	94	190,944	400,964	1.000	1.2	118	78	192,041	399,331	1.000	1.3	97	(20)	< 121
Sr	88	14	205,366	428,998	1.000	1.2	16	117	206,084	427,355	1.000	1.2	137	121	**441**
Zr	90	22	43,861	91,653	1.000	5.5	120	14	43,724	91,067	1.000	5.5	75	(45)	< 222
Mo	98	1,066	36,940	76,816	1.000	6.6	7034	1,116	36,398	78,275	0.999	6.5	7230	196	< 2,370
Ag	107	9	74,376	154,641	1.000	3.2	28	16	73,942	153,750	1.000	3.3	51	23	< 141
Cd	111	7	16,437	34,420	1.000	14.5	97	9	16,580	34,453	1.000	14.5	131	33	< 477
Sn	118	78	39,748	82,164	1.000	6.1	477	160	39,969	81,987	1.000	6.1	980	503	**1,830**
Sb	121	9	38,013	79,010	1.000	6.3	59	25	38,016	78,353	1.000	6.4	160	101	**367**
Cs	133	26	175,692	364,589	1.000	1.4	36	26	176,594	362,761	1.000	1.4	35	(0)	< 76
Ba	138	7	100,331	209,654	1.000	2.4	17	22	100,463	208,022	1.000	2.4	52	35	129
W	184	318	21,326	44,558	1.000	11.3	3591	323	21,279	43,969	1.000	11.5	3704	114	< 2,250
Pb	208	1	93,474	194,978	1.000	2.6	2	63	92,306	192,864	1.000	2.6	163	161	**586**
Pb	206	0	45,381	94,370	1.000	5.3	0	29	44,925	93,498	1.000	5.3	153	153	**559**
Si	28	9,346	15,582	21,355	1.000	4163.6	3.89.E+07	50,492	(*1) 57,201	(*2) 61429	0.992	4571.6	2.31.E+08	191,916,935	

LA frequency : 10 kHz, Galvanometer mirror scan speed : 50 mm/sec, Galvanometer mirror scan width : 1 mm (Y axis)
Wafer stage movement speed : 0.025 mm/sec (X axis),
ICP-MS data acquisition mode : Spectrum, Integration time : 1 sec/mass

Analysis of 0.5 ppb 20 nm Au particles on Si wafer

- Single nano-particle analysis of Au particles on Si wafer sample.
- 3 uL of 0.5 ppb Au particles standard solution in IPA was spiked on a Si wafer and dried.

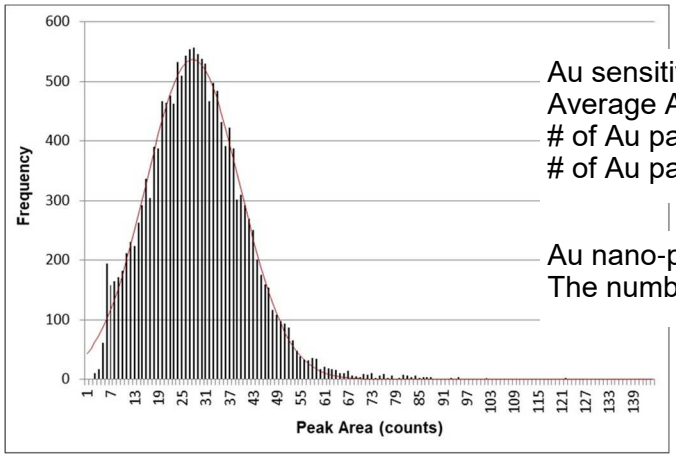




X axis full scale : 5 sec

X axis full scale : 0.002 sec

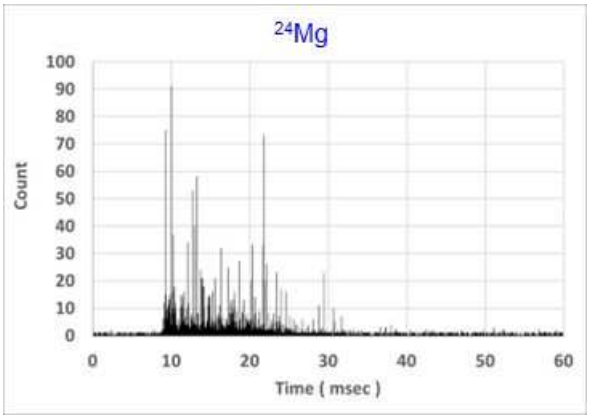
LA frequency : 10 kHz, Galvanometer mirror scan speed : 50 mm/sec, Galvanometer mirror scan width : 15 mm (X Y axis direction),
ICP-MS data acquisition mode : single nanoparticle mode, Dwell time : 0.1 msec/mass, Analysis time : 600 sec

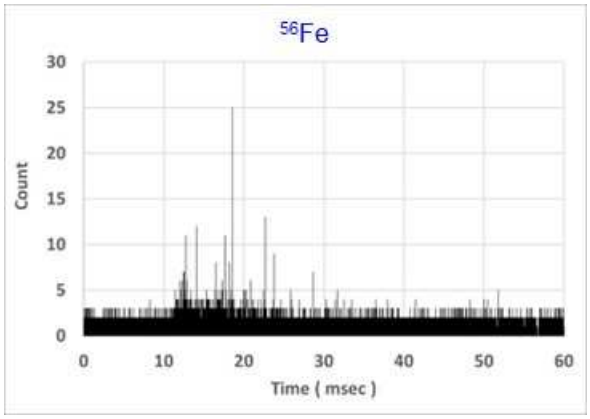


Au sensitivity by MSAG : 2.94 ag/count
Average Au particle count : 28 counts
# of Au particle in 3 µL : 19,083 pcs
# of Au particles detected : 16,009 pcs

Au nano-particle size calculated from MSAG was 20.1 nm
The number of particle recovery was 84%

Analysis of GaN wafer

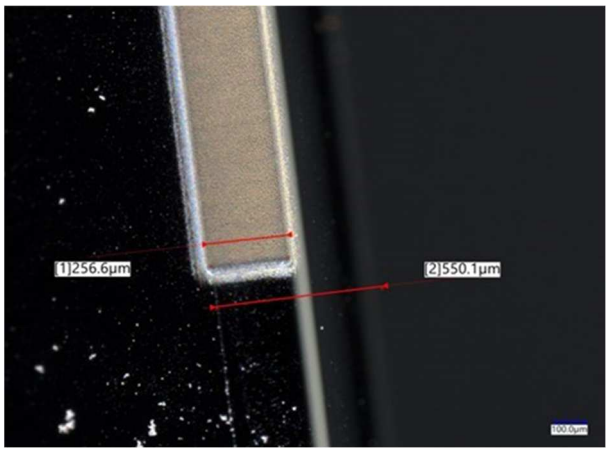




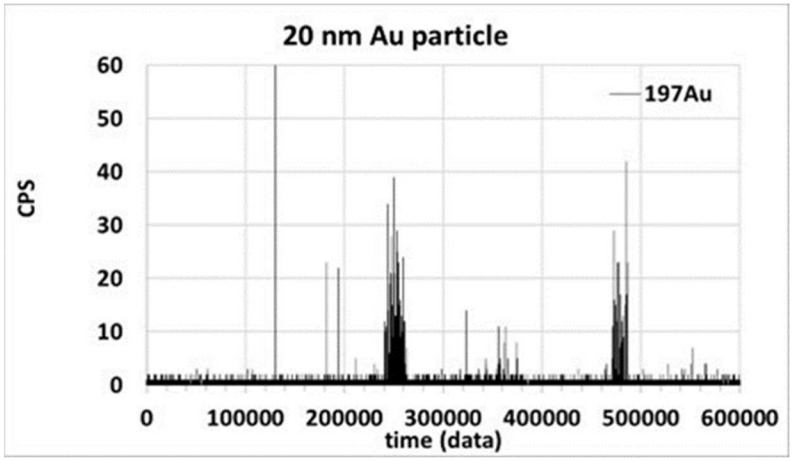
LA frequency : 10 kHz, Galvanometer mirror scan speed : 50 mm/sec, Galvanometer mirror scan width : 5 mm (Y axis direction),
Wafer stage movement speed : 0.025 mm/sec (X axis),
ICP-MS data acquisition mode : Single nano-particle analysis, Dwell time : 0.1 msec/mass, Analysis time : 60 sec

Analysis of bevel

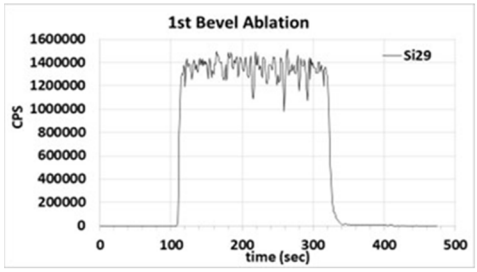
Photo of bevel area
Laser ablation width : 250 μm

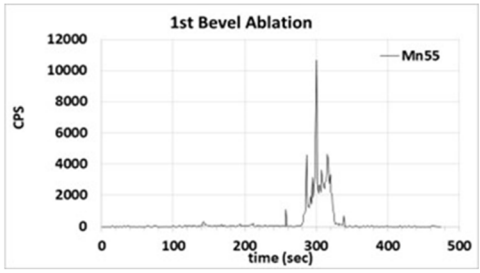


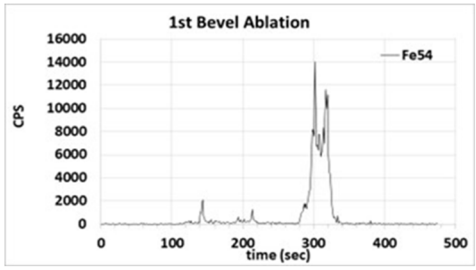
Analysis of Au particles on bevel
(Two droplets of 20 nm Au particle solution)

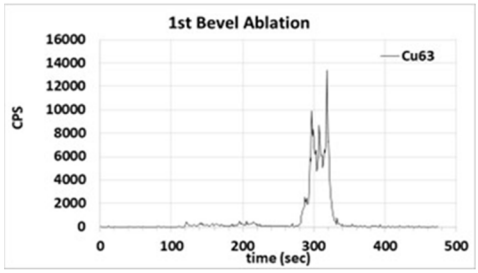


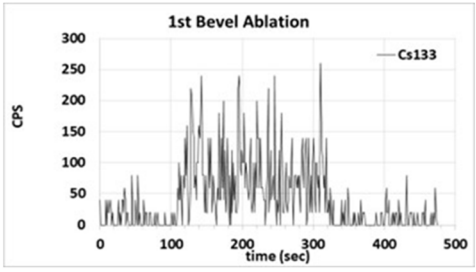
Analysis of bevel of Si wafer (1st ablation): Several impurities were found at the same spot.

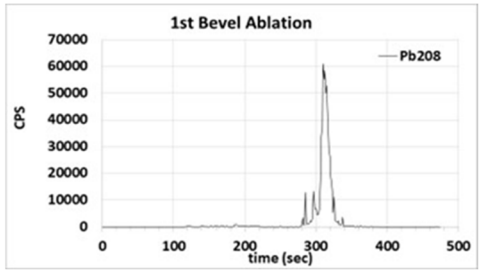




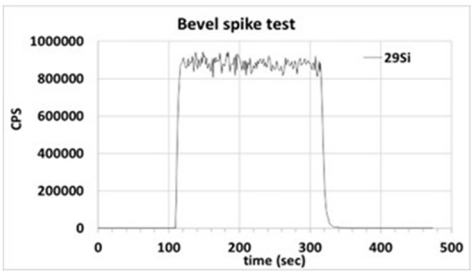


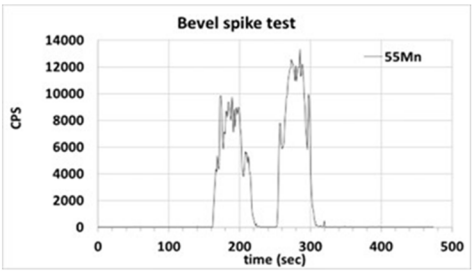


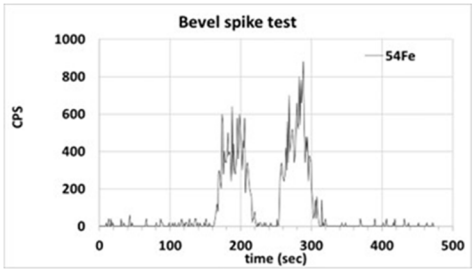


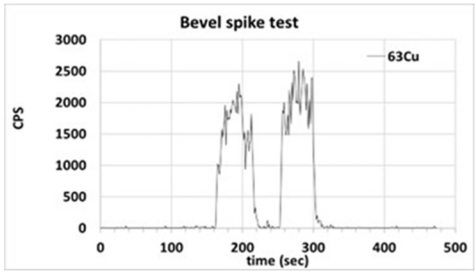


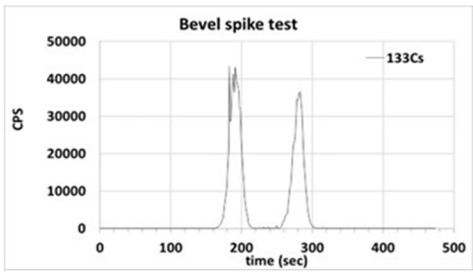
Analysis of spiked wafer (Two droplets of STD solution on the bevel area after 7 times cleaning):
Two peaks were detected.

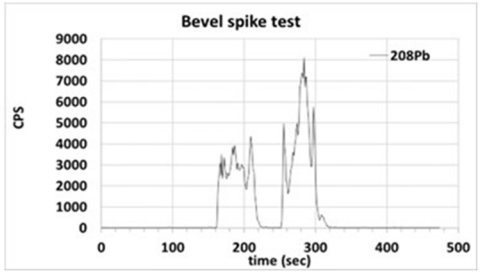












LAGM Software

LAGM software communicates with ICP-MS software that enables fully automated operation.

- Calibration mode：Calibration curves while laser ablating a sample are obtained using *MSAG_DS*.
- Full scan mode：Entire wafer is laser ablated according to the analysis time. LAGM software automatically calculates speed of X-Y-Z-θ stage to ablate the entire wafer equally.
- Spot mode：Multiple specified spots can be analyzed automatically. The spot information in KLARF format file can be imported.
- Straight mode： Straight line specified by two spots is analyzed with a specified width continuously.
- Block mode：It is similar to the straight mode, but a specified block size (e.g. 1 mm x 1 mm) is ablated for a specified time. After waiting for an interval time, the block next to the ablated block is ablated. This mode is better than the straight mode in terms of space resolution.
- Depth profile mode： The same spot with a specified size is ablated repeatedly to get depth profile information. An interval time can be set after ablating one layer, which gives better resolution of depth profile.
- Bevel mode： Multiple specified areas of wafer bevel can be analyzed automatically.

Expert_LA model includes two load ports, which enables fully automated analysis of wafer samples by setting up a recipe for each wafer. A sample wafer is taken out from one of L/Ps, and it is recovered in another L/P after analysis of wafer.

LAGM software controls MSAG_DS that has two special syringe pumps. One of syringe pumps contains a 1% HNO_3 solution and the other syringe pump contains a mixed standard solution in 1% HNO_3, which are injected at 3 μL/min in total and the ratio of two syringe pumps are changed to make

Specification and Environment

Basic components

- Femto-second laser：257 nm
- Maximum ablation frequency : 60 kHz
- Galvanometer mirror moving speed ：100 mm/sec
- X-Y-Z-θ stage
- Ejector
- GED-Q
- MSAG-DS
- Mass flow controllers
- LAGM intelligent software
- FFU（ISO class 3 environment）

Option

- Expert_LA that includes the followings:
  FOUP loader : 2 set
  Wafer transfer robot : 1 set

Environment

Temperature ：15～30℃
Humidity ：35～85%RH No condensation

Power supply, size and weight depends on the model. Please contact us.

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