Introduction of a High-Speed Multispot-Laser Ablation-ICP-MS

Yasuo Kuroki

Thermo Fisher Scientific. K.K , Japan

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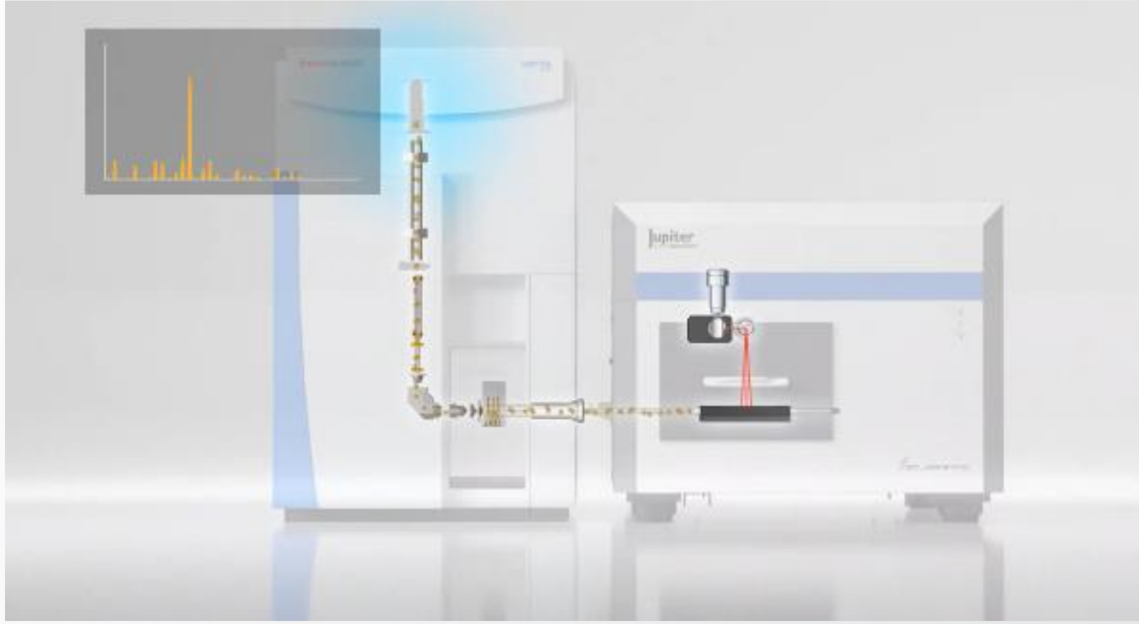
The principle of Laser ablation ICP-MS

Laser Ablation:

A process of formation of sample aerosols through irradiating of high-energy laser beam onto the surface of the solid materials.

Laser Ablation ICP-MS：

Analytical method based on the ICP-mass spectrometry coupled with laser ablation sampling technique. Laser induced sample aerosols were transported with an inert gas (He and Ar), and were introduced into the ICP ion source. With the ICP-MS technique, both the elemental and isotopic analysis can be made directly from solid materials without any chemical decomposition or dissolution processes.



Problems on conventional LA systems

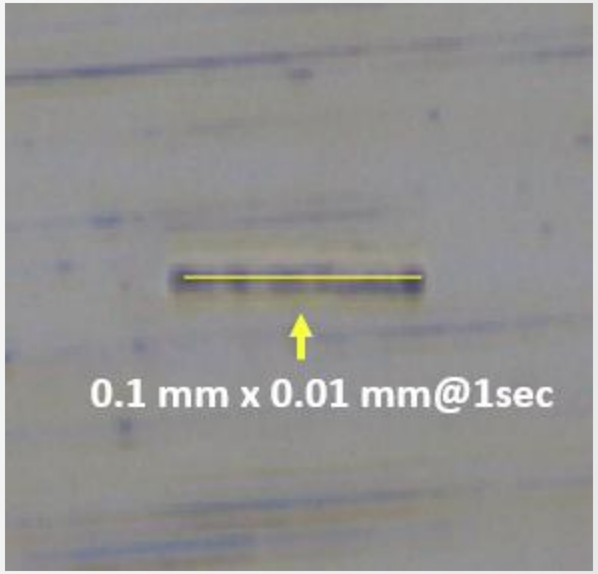
✓ Single spot ablation

Conventional laser ablation systems can only perform laser ablation from a single ablation spot on the sample.

To irradiate different spots, the stage must be scanned.

✓ Limited Analysis Area

The Nd-YAG laser, which has been widely used in LA systems in the past, can emit only 20 shots per second, which limits the sampling volume.
As a result, the amount of analyte present may deviate from the bulk composition obtained by wet chemistry.



✓ Difficult to perform precise quantitative analysis

Limited availability for the matrix-matched calibration standards.

Even if available, concentration ranges for the analytes can be too high to conduct accurate calibrations for trace-elements in unknown samples.

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Introduction of innovative Ultra High-speed Multi-spot laser ablation system, it's called "Jupiter Solid Nebulizer"

Multiple-spot laser ablation (msLA) technique

Jupiter solid nebulizer is a system capable of high-speed scanning of laser beams.

✓ Multiple-spot ablation

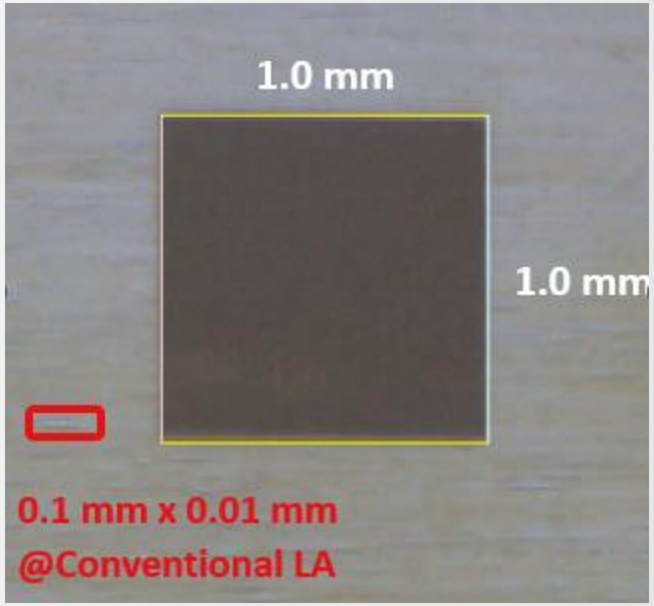
The optical system, which combines a high-repetition laser and a galvanometer scanner, allows for high-speed scanning of the laser beam.

What is the major advantage to use Jupiter solid nebulizer?

①High SBR (signal to background ratio)

②Averaging of the abundance values from potentially heterogeneous samples.

③Mixing of two or more solid materials.

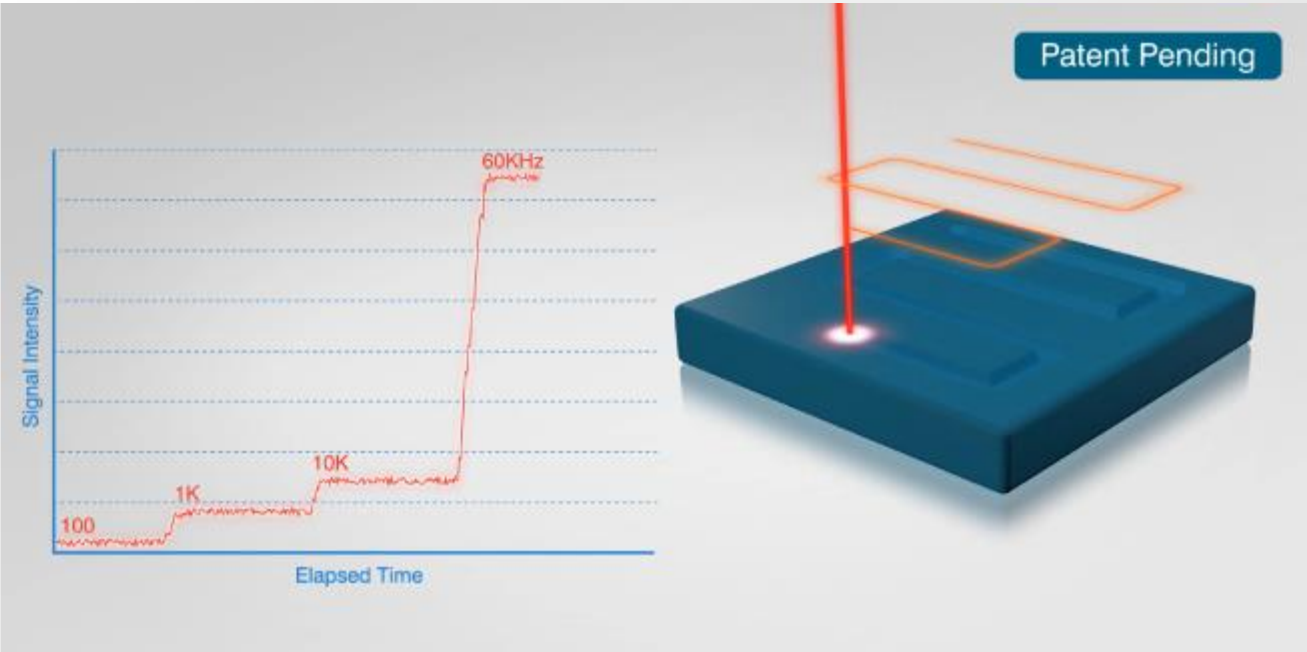


①High SBR (signal to background ratio)

The high repetition frequency laser and galvanometer optics provide high sensitivity (excellent S/B ratio) and high accuracy in bulk analysis.

What is the major advantage to use wider area of range at high speed ?

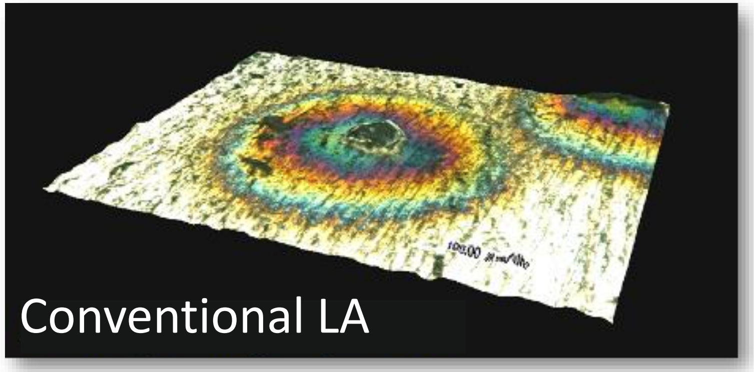
(1) Improved sensitivity (S/B) dramatically; e.g., extremely thin film(nm level) on the surface impurity can be applied.
(2) Better precision and accuracy of the measurements.

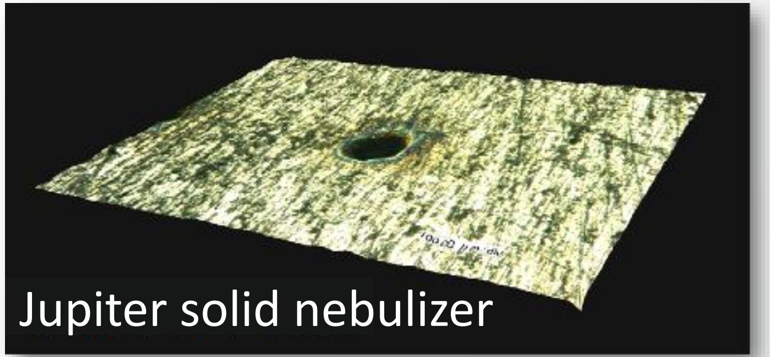


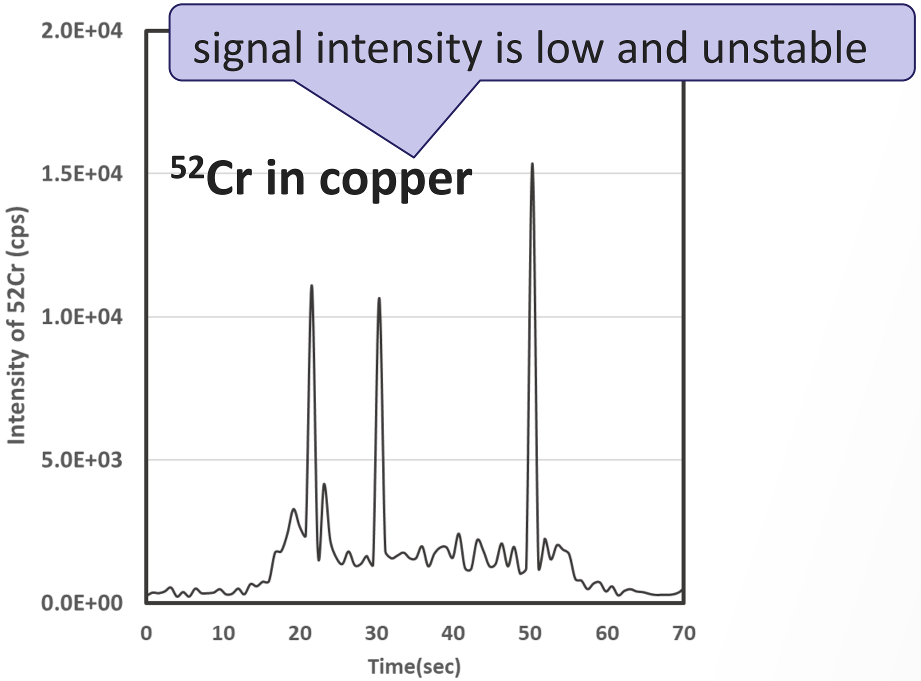
② Averaging of the abundance values from potentially heterogeneous samples

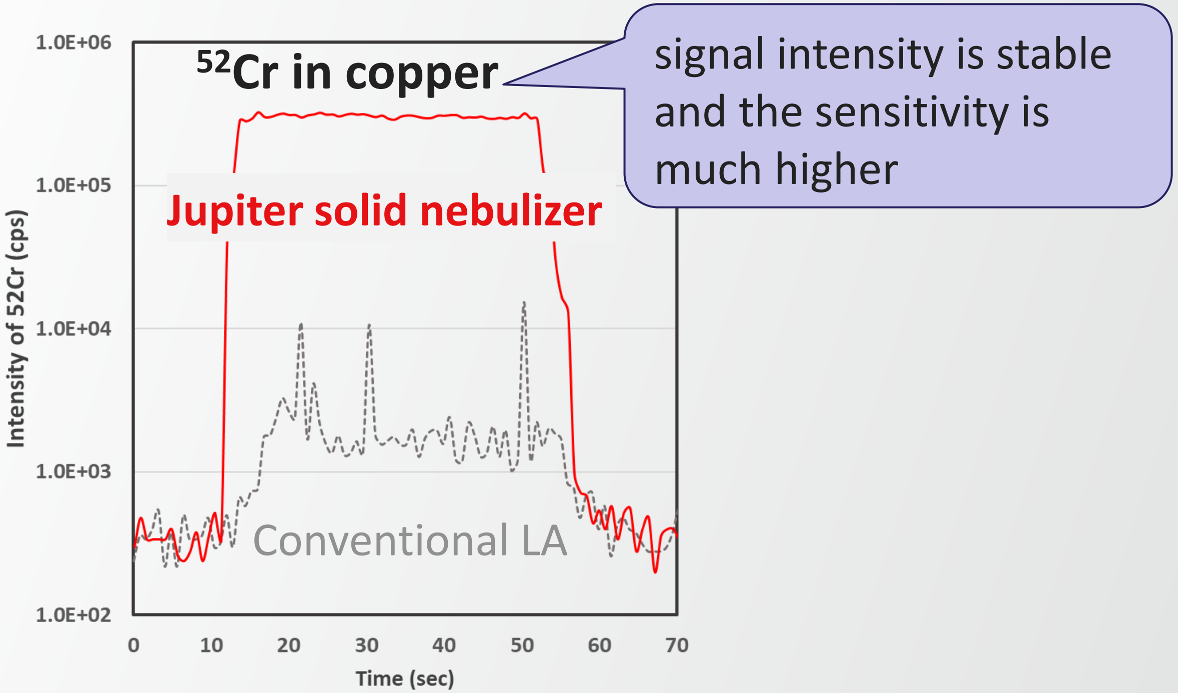
Advantages of Jupiter solid nebulizer, e.g., Metal analysis

Most metallic materials have fast thermal diffusion rates (<10^{-12} sec)





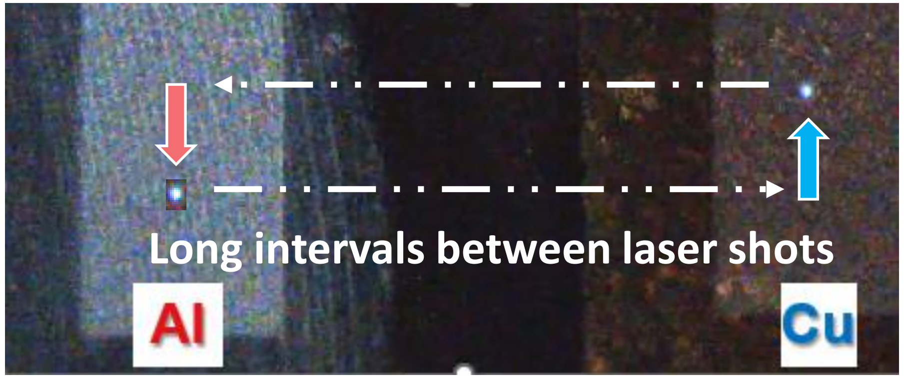




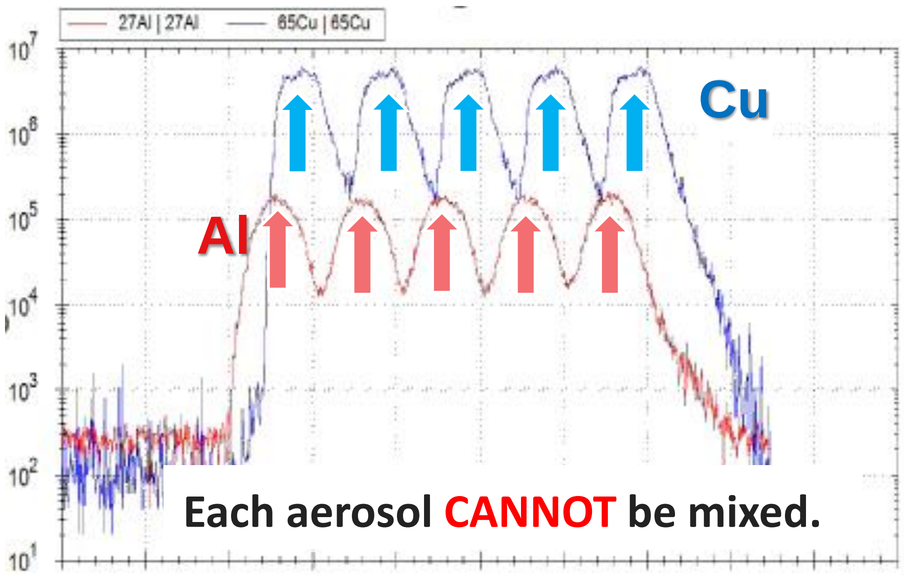
③ Mixing of two or more solid materials.

High speed jumping irradiation allows mixing of each sample aerosol.

Conventional LA(Low-repetition laser)

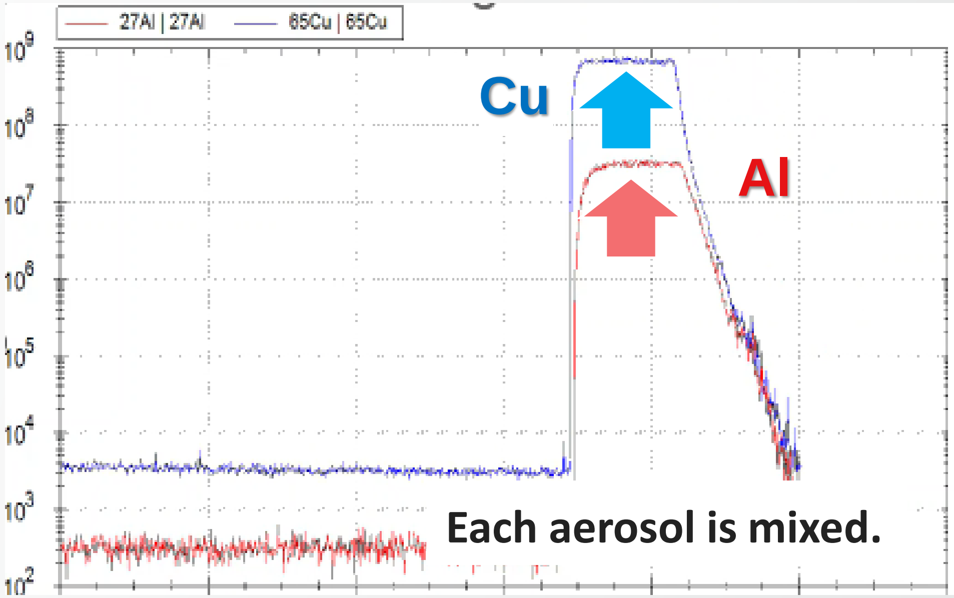


Ion intensity detected by ICP-MS



Jupiter solid nebulizer (High-repetition laser)

Ion intensity detected by ICP-MS



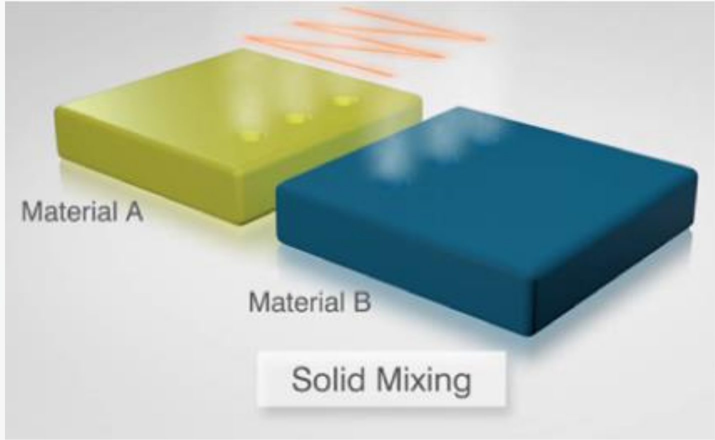
Application of aerosol mixing to create multi-point calibration curves

The compositional concentration can be controlled by changing the irradiation ratio between the two samples.

STD_A — Low concentration

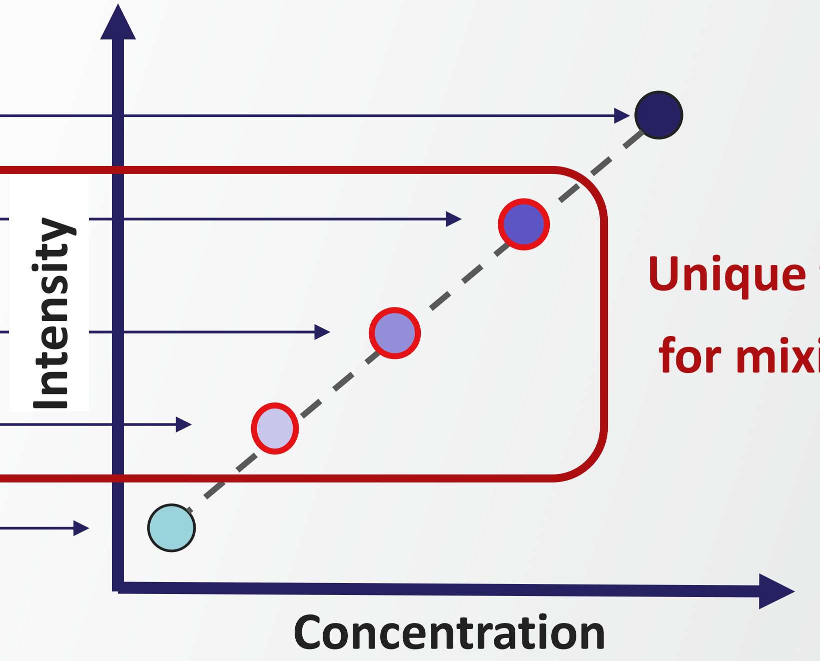
STD_B — High concentration

Identical / Similar chemical composition



Irradiation ratio

	STD_A	STD_B
Measurement_1		10
Measurement_2	4	6
Measurement_3	6	4
Measurement_4	8	2
Measurement_5	10	



Unique technology for mixing solid samples

Solid samples can be diluted and/or added as if they were in solution

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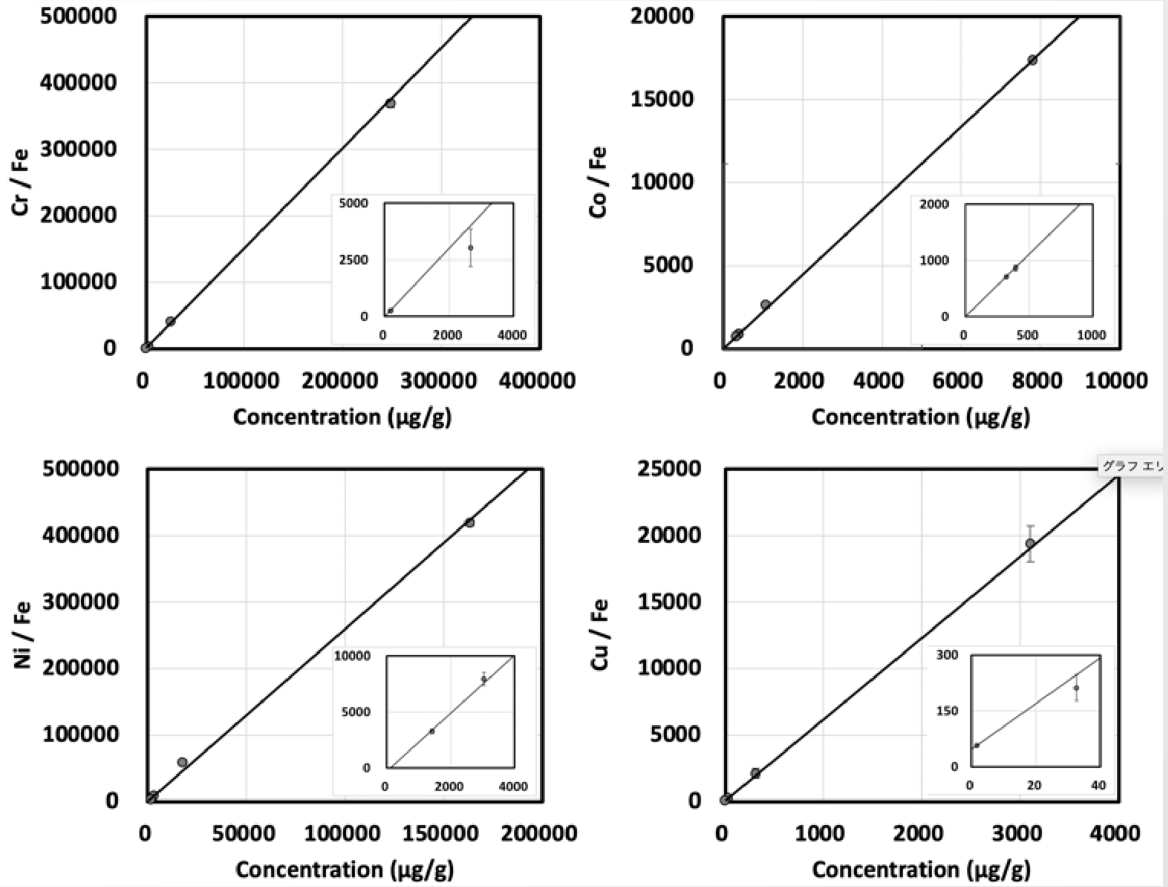
Examples of application to various iron-based samples

Determination of major to trace elements in metallic materials based on the solid mixing calibration method using multiple spot-laser ablation-ICP-MS

Yoshiki Makino, *[a] Yasuo Kuroki[b] and Takafumi Hirata[a]



In this study, abundances of Cr, Co, Ni, and Cu from 13 metallic materials (iron meteorite, stainless steels, tool steels, and low alloy steels) were measured based on the calibration curves defined by aerosol mixing method using the multiple spot-LA-ICP-MS technique.

Provides new possibilities for direct solid analytical methods

Various applications from bulk quantitative analysis to 3D imaging analysis

Quantitative analysis

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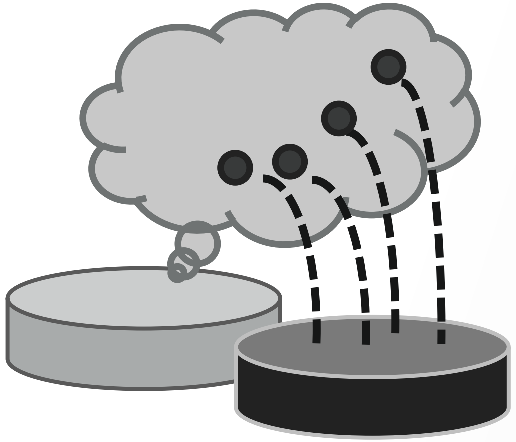
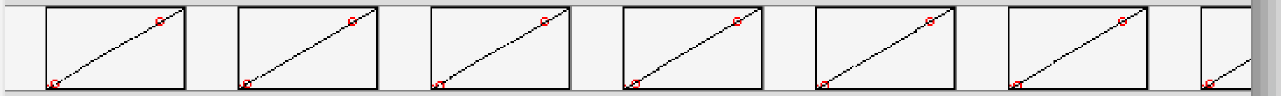
Determination of average composition

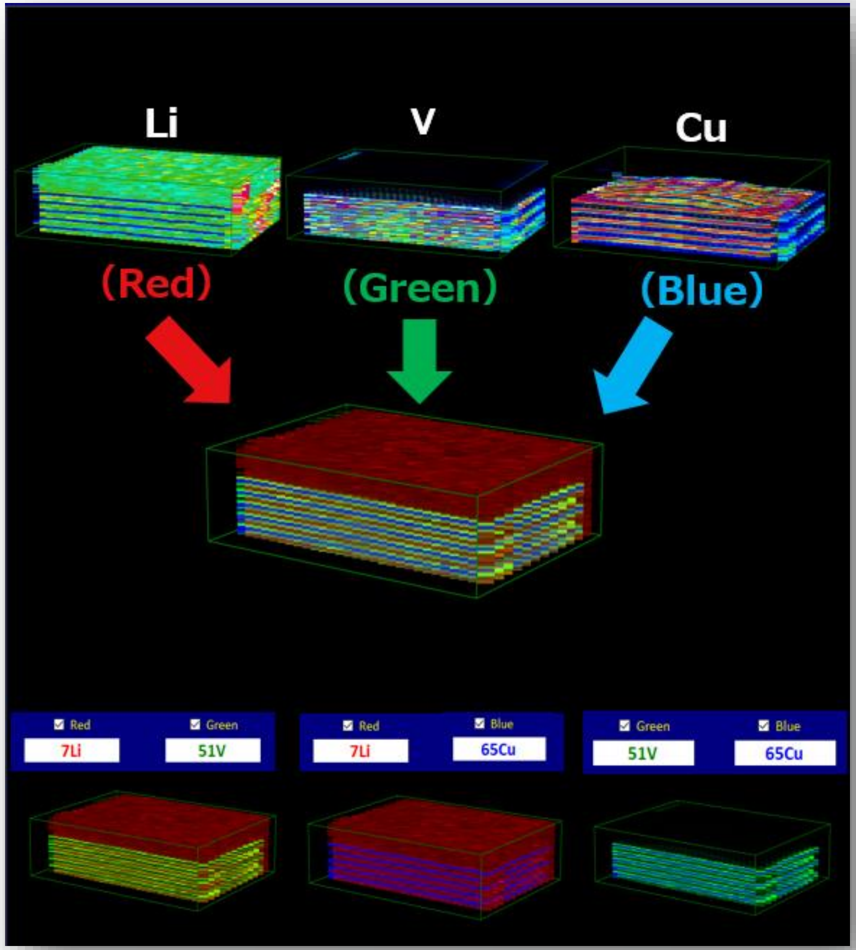


51V | 51V (L-TQ	52Cr | 52Cr (L-T	55Mn | 55Mn (L-	56Fe | 56Fe (L-T	59Co | 59Co (L-	60Ni | 60Ni (L-T	63Cu | 63
0.000	0.000	0.000	0.000	0.000	0.000	
450.154 (450.000)	408.410 (408.000)	444.709 (444.000)	459.111 (458.000)	410.463 (410.000)	459.156 (458.700)	441.340
37.014 (38.800)	31.808 (36.400)	30.566 (38.700)	41.021 (51.000)	30.148 (35.500)	33.406 (38.800)	33.83



51V | 51V (L-TQ	52Cr | 52Cr (L-T	55Mn | 55Mn (L-	56Fe | 56Fe (L-T	59Co | 59Co (L-	60Ni | 60Ni (L-T	63Cu | 63
0.039	3.113	107,733.663	4.873	66,863.487	150,480.510	
0.026	4.262	93,634.720	6.748	125,682.963	133,433.902	
0.643	4.716	124,888.329	5.196	73,534.773	174,990.510	
0.056	4.438	167,803.294	7.192	131,751.131	342,761.009	
0.021	4.057	92,610.487	6.579	127,132.688	131,109.028	

2D/3D imaging analysis



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TANAKA KIKINZOKU GROUP

LBMA GOOD DELIVERY REFEREE

Thank you for your attention.
Please do not hesitate to send any inquiries to

yasuo.kuroki @thermofisher.com
yasuhiko.kato@thermofisehr.com

@ Thermo Fisher Scientific. K.K , Japan