High precision Nd isotope ratio measurements

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Introduction

The Thermo Scientific™ Neoma™ MC-ICP-MS is the latest high performance MC-ICP-MS, with market-leading sensitivity, isotope ratio precision and accuracy. It enables high throughput for routine isotope ratio applications.

High precision Nd isotope ratio determination is one of the most important MC-ICP-MS applications. It benefits from the enhanced variable detector array at the heart of the Neoma MC-ICP-MS, enabling all relevant interferences to be monitored simultaneously. No compromises required.

Method

A 100 ppb Merck™ Nd solution was introduced into the Neoma MC-ICP-MS with a 100 µL/min self-aspirating nebulizer and SIS spray chamber. The cup configuration with amplifier assignment are reported in Table 1. An 8 s integration time was used to measure 10 blocks, each of 10 minute measurement total time. Ratio were internally normalized to $^{146}Nd/^{144}Nd$ using the exponential mass bias model. Isobaric interference corrections were applied for Ce and Sm. The large dispersion of Neoma allows static monitoring of $^{142}Nd^{16}O$, enabling tuning against oxide interferences.

Results

For an aspiration rate of 100 µL/min the total Nd sensitivity was calculated at 7.91 Gcps/ppm, or 127 V/ppm (10^{11} Ω scale). This sensitivity is approximately a factor 2 better than that typically achievable on previous generations of MC-ICP-MS.

The resolving power was calculated as approximately 1,950 (Figure 1), for all measurement cups.

Table 1. Nd cup configuration and amplifier assignment

Cup	L5	L4	L3	L2	L1	C	H1	H2	H3	H4	H5
Amplifier	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω	10^{11} Ω
Isotope	^{140}Ce	^{142}Nd	^{143}Nd	^{144}Nd	^{145}Nd	^{146}Nd	^{147}Sm	^{148}Nd	^{149}Sm	^{150}Nd	$^{142}Nd^{16}O$

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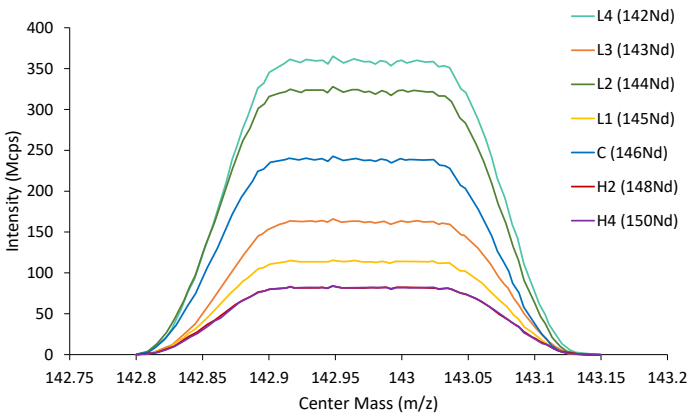

Figure 1. Mass scan of all Nd isotopes, ^{146}Nd in the central Faraday cup. Resolving power ≈ 1950.

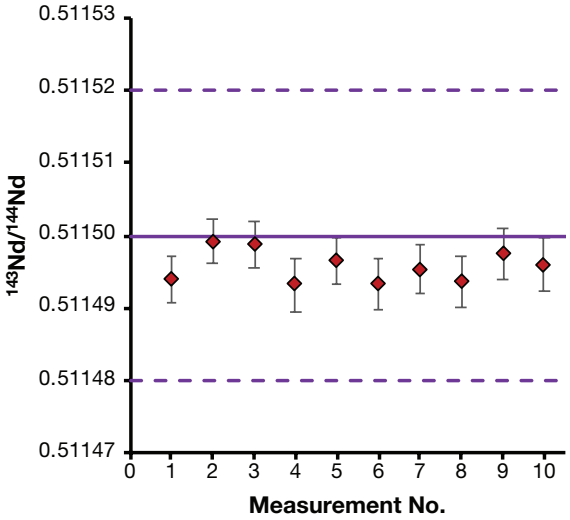

Figure 2. ^{143}Nd/^{144}Nd for 10 measurement blocks of 10 min. Accepted ^{143}Nd/^{144}Nd of the standard Merck solution is denoted by the solid purple line. The acceptance window for accuracy is denoted by the dotted lines.

The accuracy of the measured mean ^{143}Nd/^{144}Nd was in good agreement with the accepted value for the standard Merck Nd solution and falls easily within the accepted accuracy window of ±40 ppm (Figure 2).

For all reported isotope ratios, the reported reproducibility was better than 15 ppm RSD (Table 2). Such precision was not specified on previous generation MC-ICP-MS, even with solutions that were double the concentration.

Conclusion

The Neoma MC-ICP-MS can achieve uniquely high sensitivity for Nd isotope analysis in wet plasma. This high sensitivity enables high precision measurements at half the sample amount.

Table 2. Sensitivities of each Nd isotope (in Mcps) and ^{142}Nd/^{144}Nd, ^{143}Nd/^{144}Nd, ^{145}Nd/^{144}Nd, ^{148}Nd/^{144}Nd, ^{150}Nd/^{144}Nd isotope ratios for 10 replicate measurements of 100 ppb Merck standard Nd solution.

	^{142}Nd	^{143}Nd	^{144}Nd	^{145}Nd	^{146}Nd	^{148}Nd	^{150}Nd	^{142}Nd/^{144}Nd	^{143}Nd/^{144}Nd	^{145}Nd/^{144}Nd	^{148}Nd/^{144}Nd	^{150}Nd/^{144}Nd
1	218	99	196	69	145	50	50	1.141720	0.511494	0.348416	0.241544	0.236367
2	214	97	192	68	142	49	49	1.141762	0.511499	0.348415	0.241541	0.236361
3	212	96	190	67	141	48	48	1.141747	0.511499	0.348417	0.241542	0.236363
4	210	95	189	67	140	48	48	1.141730	0.511493	0.348413	0.241542	0.236365
5	209	95	188	66	139	48	48	1.141749	0.511497	0.348415	0.241542	0.236365
6	209	95	187	66	139	47	48	1.141744	0.511493	0.348417	0.241542	0.236364
7	207	94	185	65	137	47	47	1.141743	0.511495	0.348418	0.241547	0.236373
8	206	93	185	65	136	47	47	1.141745	0.511494	0.348418	0.241546	0.236371
9	203	92	182	64	135	46	46	1.141747	0.511497	0.348418	0.241548	0.236371
10	202	92	181	64	134	46	46	1.141758	0.511496	0.348414	0.241545	0.236365
	^{142}Nd	^{143}Nd	^{144}Nd	^{145}Nd	^{146}Nd	^{148}Nd	^{150}Nd	^{142}Nd/^{144}Nd	^{143}Nd/^{144}Nd	^{145}Nd/^{144}Nd	^{148}Nd/^{144}Nd	^{150}Nd/^{144}Nd
Mean	209	95	188	66	139	48	48	1.141745	0.511496	0.348416	0.241544	0.236366
SD	5	2	4	2	3	1	1	0.000012	0.000002	0.000002	0.000002	0.000004
RSD (ppm)								11	4	5	10	17

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