APPLICATION BRIEF 000097

High precision hafnium isotope ratio measurements

Authors: G. Craig, M. Pfeifer, C. Bouman, N. Lloyd, J. Schwieters; Thermo Fisher Scientific, Bremen, Germany

Keywords: Neoma, MC-ICP-MS, Hf, isotope ratio, Geosciences

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 hafnium isotope ratio measurements, the original key MC-ICP-MS application, benefit from the power of the Neoma MC-ICP-MS. The enhanced variable detector array at the heart of the instrument is capable of automated alignment of the 11 Faraday cup detectors on all required masses.

Method

A 200 ppb Hf solution was introduced into the Neoma MC-ICP-MS with a 100 µL/min self-aspirating nebulizer and SIS spraychamber. 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. Ratios were internally normalized to $^{179}Hf/^{177}Hf$ using the exponential mass bias model. Isobaric interference corrections were applied for Yb, Lu, Ta and W.

Results

For the measured aspiration rate of 115 µL/min, the total Hf sensitivity was calculated at 5.23 Gcps/ppm, or 83.7 V/ppm (10^{11} Ω scale). This is approximately double the specified sensitivity of previous generation MC-ICP-MS on the market.

Table 1. Hf cup configuration and average isotope sensitivities for a 200 ppb Hf solution. N = 10.

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	^{171}Yb	^{173}Yb	^{174}Hf	^{175}Lu	^{176}Hf	^{177}Hf	^{178}Hf	^{179}Hf	^{180}Hf	^{181}Ta	^{182}W
Mean (cps)	-130	1500	$1.87x10^6$	5120	$6.19x10^7$	$2.21x10^8$	$3.27x10^8$	$165x10^8$	$4.29x10^8$	12020	8270

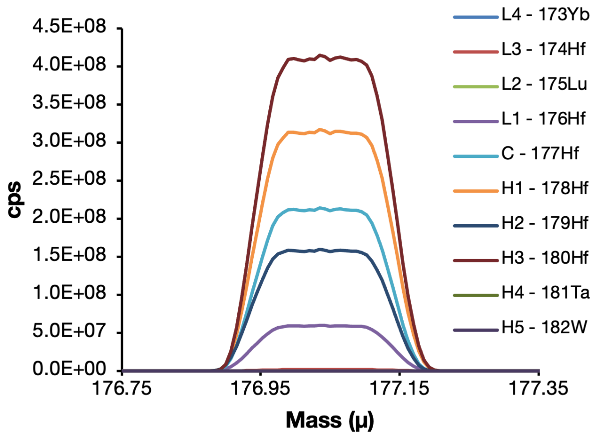

Figure 1. Mass scan of all Hf isotopes, ^{177}Hf in the central Faraday cup. Mass resolving power ≈ 1950.

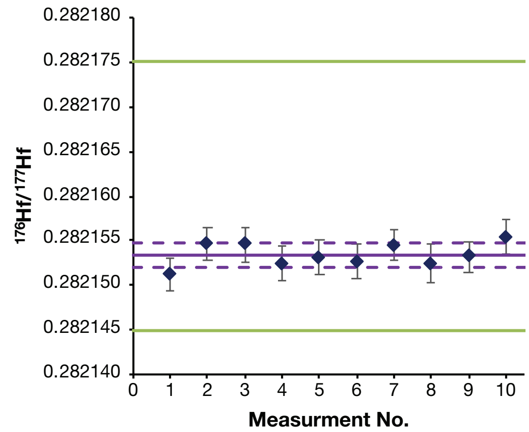

Figure 2. ^{176}Hf/^{177}Hf for 10 measurement blocks of 10 min. Error bars given are 1 SE (black) and 1 SD (dashed purple). The acceptance window for accuracy is denoted by green lines.

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

The accuracy of the measured mean ^{176}Hf/^{177}Hf fitted well within an accuracy window of -25 ppm to +55 ppm from the accepted standard value (Figure 2). Reported precisions for the three major isotope ratios, ^{176}Hf/^{177}Hf, ^{178}Hf/^{177}Hf and ^{180}Hf/^{177}Hf were better than 10 ppm RSD (Table 2). Individual block hafnium isotope ratio SE's are at the limit dictated by counting statistics.

Conclusion

The sensitivity of the Neoma MC-ICP-MS for Hf in wet plasma is approximately twice as high as previous generation MC-ICP-MS. This unique sensitivity enables high precision Hf isotope ratios with the three major isotopes ratios reporting precisions of better than 10 ppm RSD for a 200 ppb Hf solution.

Table 2. ^{176}Hf/^{177}Hf, ^{178}Hf/^{177}Hf and ^{180}Hf/^{177}Hf isotope ratios for 10 replicate measurements of 200 ppb Hf solution

	^{174}Hf/^{177}Hf	SE	RSE (ppm)	^{176}Hf/^{177}Hf	SE	RSE (ppm)	^{178}Hf/^{177}Hf	SE	RSE (ppm)	^{180}Hf/^{177}Hf	SE	RSE (ppm)
1	0.0086540	0.0000009	99	0.2821512	0.0000019	6.6	1.467216	0.0000052	3.5	1.886750	0.000010	5.2
2	0.0086546	0.0000007	84	0.2821547	0.0000019	6.7	1.467226	0.0000039	2.7	1.886772	0.000011	5.9
3	0.0086559	0.0000008	93	0.2821546	0.0000019	6.8	1.467221	0.0000041	2.8	1.886756	0.000008	4.4
4	0.0086569	0.0000009	103	0.2821524	0.0000019	6.8	1.467223	0.0000044	3.0	1.886756	0.000011	5.6
5	0.0086562	0.0000008	93	0.2821531	0.0000020	6.9	1.467225	0.0000042	2.9	1.886764	0.000012	6.2
6	0.0086561	0.0000008	96	0.2821527	0.0000019	6.8	1.467220	0.0000042	2.9	1.886752	0.000010	5.3
7	0.0086553	0.0000010	111	0.2821545	0.0000017	5.9	1.467220	0.0000038	2.6	1.886751	0.000012	6.2
8	0.0086576	0.0000007	82	0.2821524	0.0000021	7.5	1.467222	0.0000043	2.9	1.886758	0.000009	4.9
9	0.0086571	0.0000010	115	0.2821532	0.0000017	6.2	1.467221	0.0000036	2.5	1.886728	0.000009	4.8
10	0.0086555	0.0000008	88	0.2821554	0.0000019	6.8	1.467222	0.0000049	3.4	1.886744	0.000011	6.0
	^{174}Hf/^{177}Hf	**SE**	**RSE (ppm)**	**^{176}Hf/^{177}Hf**	**SE**	**RSE (ppm)**	**^{178}Hf/^{177}Hf**	**SE**	**RSE (ppm)**	**^{180}Hf/^{177}Hf**	**SE**	**RSE (ppm)**
Mean	0.0086559	0.0000008	96	0.2821534	0.079	6.7	1.4672214	0.0000043	2.9	1.886753	0.000010	5.5
SD	0.0000011			0.0000013			0.000003			0.000012		
RSD (ppm)	127			4.7			2.0			6.1		

Find out more at **thermofisher.com/neoma**

ThermoFisher SCIENTIFIC