nu plasma II

MULTI COLLECTOR ICP-MS

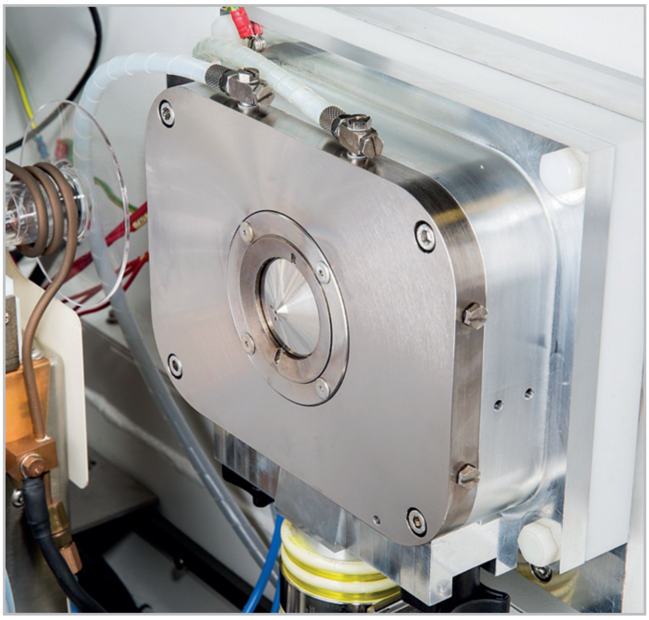
TECHNICAL NOTE **AN27**

NU PLASMA II-ES MC-ICP-MS INSTRUMENT: THE LATEST IMPROVEMENT IN SENSITIVITY WITH NO COMPROMISE IN ANALYTICAL PERFORMANCE.

INTRODUCTION

A new Enhanced Sensitivity (ES) interface is now available as an option to the Nu Plasma II, as well as an upgrade to existing Nu Plasma II's and as an upgrade to all Nu Plasma HR customers. The ES package includes a newly designed interface chamber and a set of specially manufactured sampling and skimmer cones (Fig.1). The setup maximises the intermediate vacuum, which together with enhanced transfer optics allows for improved analytical capabilities for the instrument. We present sensitivity enhancement data over the whole mass range, together with Nd and Hf isotope ratio measurements for accuracy and precision validation purposes.

Fig. 1: New interface for Nu Plasma II fitted with high sensitivity cones



Instrumental Settings

All data were obtained in low resolution mode and dry plasma conditions, using a DSN-100 desolvation system (Nu Instruments, U.K.) fitted with a MicroMist nebuliser (Glass Expansion, Australia) working at an uptake rate of 0.09mL.min^{-1}. A multi-element tune solution containing 10ng.g^{-1} of Li, Mg, Sr, Nd, Hf, Pb and U (from Alfa Aesar 1,000μg.g^{-1} single element stocks) was used for the sensitivity tests, and reference materials JNdi-1 (Geological Survey of Japan) and JMC-475 (Johnson Matthey, U.K.) were used for the Nd and Hf isotopic analyses respectively. The Nu Plasma II instrument and DSN-100 settings used are given in Table 1.

Table 1: Nu Plasma II and DSN-100 settings used

Nu Plasma II

Coolant gas flow rate	15.0 L.min^{-1}
Auxiliary gas flow rate	0.88 to 0.94 L.min^{-1}
Plasma Power	1300 W

DSN-100

Sample uptake rate	0.09 mL.min^{-1}
Nebuliser pressure	30 to 34 psi
Hot gas flow rate (Ar or N_2)	0 to 0.18 L.min^{-1}
Membrane gas flow rate	3.2 to 3.8 L.min^{-1}
Spray chamber temperature	108° C
Membrane temperature	111° C

Enhanced Sensitivity

A multi-element solution containing 10ng.g^{-1} of the relevant elements is used to assess the instrumental sensitivity of the new enhanced sensitivity option compared with the standard dry plasma setup. Over a period of time, tests were performed to evaluate the typical enhancement achievable. Typical sensitivity results are given in Table 2.

Overall, using the ES option, the sensitivity is improved by a factor of at least 1.8 over the whole mass range, with many elements showing significantly above that value (>2.5 for Li, Mg, Sr, Pb and U).

Table 2: Elemental sensitivity achieved using the standard dry plasma setup and enhanced sensitivity package

Isotopes	Li	Mg	Sr	Nd	Hf	Pb	U
Standard Spec. (V.ppm^{-1})	120	160	250	300	350	450	400
Enhanced Sensitivity. (V.ppm^{-1})	400	500	700	650	650	1200	1000

Isotope Ratio Determination

Oxide generation

It has been reported in the literature that the excessive generation of oxides during an analysis can significantly affect the isotopic ratios data, especially for an element such as Nd[1]. In order to keep the oxide levels under control, N2 was used as the hot gas instead of Ar to regulate the production of NdO. For Hf, this was not necessary as no significant oxide levels could be detected with the ES interface. The levels of Nd oxides were measured by monitoring ^{142}Nd and $^{142}Nd^{16}O$ using a dynamic sequence, over 20 cycles of 5s integration for each analyte and a baseline by beam deflection over 30s. This was performed before and after every Nd isotopes analysis, and results were ≤ 0.10% in all cases.

Isotopic data

Data were obtained by running analyses of solutions containing 50ng.g^{-1} of JNdi-1 and JMC-475 for Nd and Hf respectively. One analysis consisted of two blocks of 25 cycles each and 10s integration per run, with a baseline for 30s at the beginning of each block. A total of 10 analyses constituted a full sequence and lasted for about 1¾ hours. Figures 2 and 3 as well as Table 3 show the reproducibility and accuracy for Nd and Hf isotope ratios analysed using the ES package.

Fig. 2: Reproducibility for $^{143}Nd/^{144}Nd$ (JNdi-1).
Mean value = 0.512111, RSD = 12ppm (2σ); error bars are 2SE

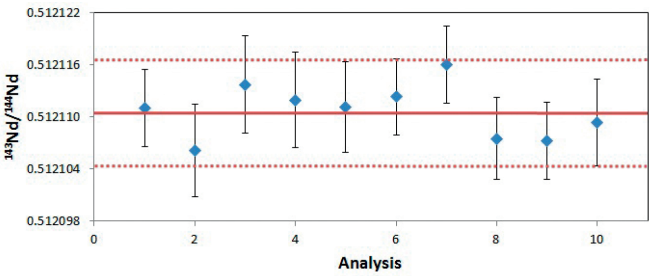


Fig. 3: Reproducibility for $^{176}Hf/^{177}Hf$ (JMC-475).
Mean value = 0.282174, RSD = 15ppm (2σ); error bars are 2SE

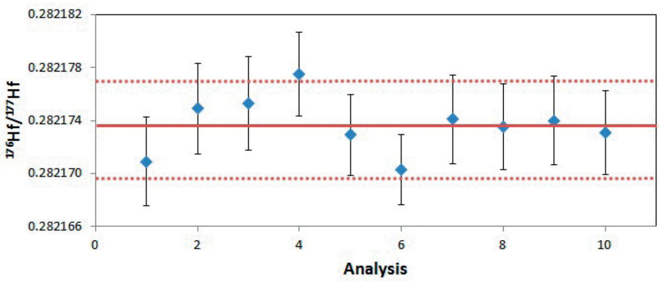


Table 3: Precision and accuracy obtained for Nd and Hf isotopes ratios over a 10-run analysis sequence. External and internal precision are 2RSD and 2RSE (max.) respectively (in ppm).
[i]Accepted values obtained from GeoRem2 database: MC-ICP-MS or TIMS (*) averages only. Ratios are within the range of values reported for MC-ICP-MS (excluding TIMS values).

Ratio	Average	Ext.	Int.	Accepted Value[i]
$^{142}Nd/^{144}Nd$	1.14180	14	17	*1.14185
$^{143}Nd/^{144}Nd$	0.512111	12	11	0.512113
$^{145}Nd/^{144}Nd$	0.348428	13	8	*0.348404
$^{148}Nd/^{144}Nd$	0.241561	9	15	*0.241589
$^{150}Nd/^{144}Nd$	0.236405	35	22	*0.236467
$^{176}Hf/^{177}Hf$	0.282174	15	13	0.282158
$^{178}Hf/^{177}Hf$	1.46726	14	5	1.46723
$^{180}Hf/^{177}Hf$	1.88674	17	8	1.88677

Conclusions

The Enhanced Sensitivity interface improves the overall sensitivity by a factor of at least 1.8 across the mass range compared to standard dry setup without compromising the analytical performance of the instrument, thus opening up further possibilities in the use of ICP-MS technology. With the addition of small amounts of N_2 gas, the enhanced sensitivity interface has minimal effect on oxide levels compared with the standard interface. The precision and accuracy of isotopic data analyses remains excellent.

[1]K. Newman, P. A. Freedman, J. Williams, N. S. Belshaw and A. N. Halliday (2009) High sensitivity skimmers and non-linear mass dependant fractionation in ICP-MS. *Journal of Analytical Atomic Spectrometry* 24, p. 742-751.

[2]GeoRem: Geological and Environmental Reference Materials, version 15 (March 2013). http://georem.mpch-mainz.gwdg.de/