Application Brief 43260

Interference Free Detection of the Radioactive Iodine Isotope ^{129}I using Oxygen as a Reactive Gas

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Key Words

ICP-MS, Oxygen, Reaction Cell Mode, Radioactive Iodine Isotopes, Xenon

Goal

This application illustrates the use of the Thermo Scientific iCAP Q ICP-MS QCell technology operated as a reaction cell using oxygen for the removal of Xe based isobaric interferences that affect the detection of the radioactive iodine isotopes (e.g. ^{129}I).

Introduction

Following the accident in the nuclear power plant in Chernobyl, Russia and more recently Fukushima, Japan, the analysis of the radioactive iodine isotopes (^{127}I, ^{129}I) have become of interest. The isotope ^{129}I has a half-life of 15.7 million years and is still found in the environment after the extensive testing of nuclear bombs in the 1950s and 1960s.

Due to its radioactive properties (emission of beta and gamma radiation) the presence of iodine can be monitored using liquid scintillation counting and gamma spectroscopy - two methods that require extensive sample treatment and long analysis times.

The direct determination of iodine is feasible with ICP-MS. However, only the naturally occurring isotope ^{127}I has no isobaric overlap and can be detected interference free with removal of polyatomic interferences. For the measurement of radioisotope ^{129}I, isobaric interferences derived from xenon (Xe) (present as an impurity in argon (Ar) gas used for plasma generation) can contribute to the observed signal intensity and lead to an elevated blank equivalent concentration (BEC). For the determination of low ^{129}I concentrations, the presence of Xe poses a serious challenge for accurate detection.

Another radioactive isotope of iodine is ^{131}I, which is one of the main products of the nuclear fission of uranium. Due to its short half-life of eight days, its presence in the environment is usually observed only shortly after exposure. However, due to its high volatility, it is easily distributed and can lead to serious health damage. Also in this case, the presence of Xe as an isobaric interference can be a limiting factor and a similar strategy for interference removal must be applied.

Method

Three different ways of operating the QCell of the Thermo Scientific™ iCAP™ Qc ICP-MS have been evaluated for the removal of the isobaric interference ^{129}Xe, which affects the detection of the respective isotope of iodine. The three approaches tested were:

- operation in STD mode (no interference removal)
- operation in KED mode using 100% He at a flow rate of 5 mL· min^{-1} (kinetic energy discrimination)
- operation in CCT mode using 100% O_2 at a flow rate of 0.4 mL· min^{-1} (reaction cell approach)

The iCAP Q ICP-MS was tuned normally using the dedicated autotune routines included in the Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution™ (ISDS) Software. The routines include a generic tune procedure for STD, KED and CCT modes. All iodine containing solutions were prepared in 0.5% tetramethylammoniumhydroxide (TMAH) in order to avoid the evaporation of iodine from the samples.

Results

A mass spectrum of the region between *m/z* 120 to 140 is shown in Figure 1 for the three different measurement modes used.

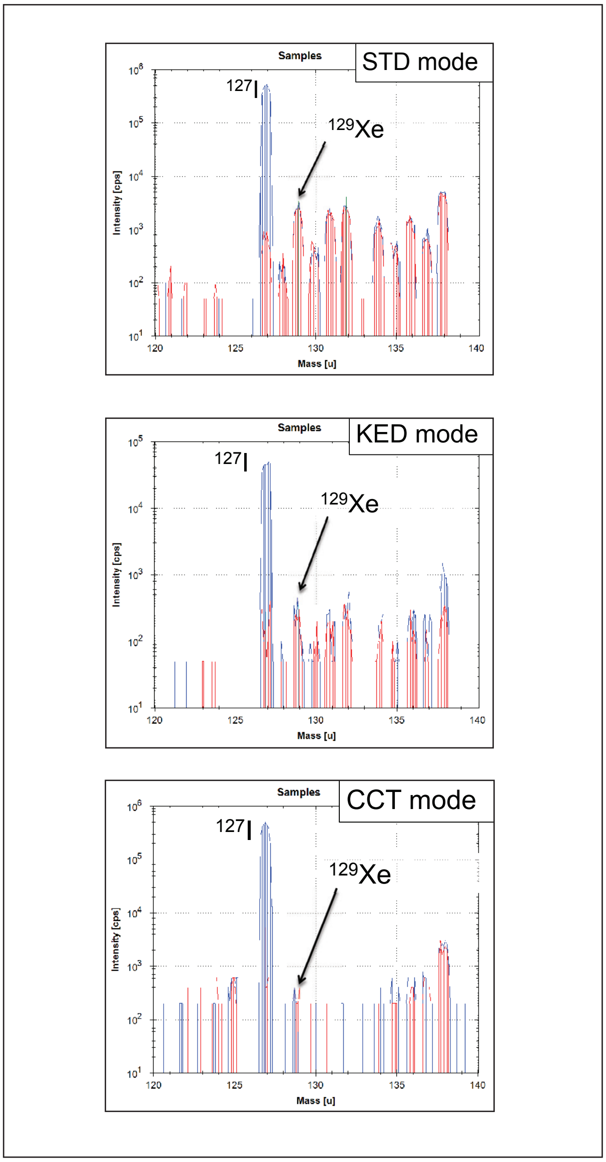

Figure 1. Mass spectrum acquired in the range between m/z 120 to 140 using different measurement modes.

The mass spectrum shows that the presence of Xe as an impurity in the Ar gas is clearly visible in the STD mode, confirmed by the matching isotopic fingerprint. Using the KED mode, the observed count rate for the iodine and the Xe isotopes are equally reduced. Due to its isobaric nature, the interference is not fully removed, as kinetic energy discrimination is only an effective tool for polyatomic interferences.

Using the CCT mode with pure O_2 as a cell gas, the interference is completely eliminated, while analyte signal remains unchanged.

Table 1 gives an overview on the attainable analytical figures of merit for each of the measurement modes investigated. Due to restrictions in the handling of radioactive isotopes all calculations of LOD and BEC values were made using the detection sensitivity of ^{127}I.

Table 1. Background intensity on *m/z* 129, attainable detection sensitivity, calculated BEC and LOD values for each mode.

Mode	Intensity *m/z* 129	Sensitivity ^{127}I (kcps/ppb)	BEC (ppt)	LOD (ppt)
STD	2480	52.8	46.9	6.9
KED	237	4.9	48.3	49.3
CCT	44	49.4	0.89	0.08

Instrument set-up

The iCAP Qc ICP-MS was tuned using the autotune routines supplied with the default installation of the Qtegra ISDS Software. These autotune routines are generic and optimize cell parameters independently of the gas used in the cell. Manual tuning of the CCT gas flow rate was also performed in order to compare results and to verify the correct function of the autotune. Figure 2 shows the obtained results of manual tuning of the CCT gas flow. It can be seen that the flow rate determined by the autotune (0.4 mL· min^{-1}) is actually the best possible condition, offering the lowest BEC value and the highest detection sensitivity.

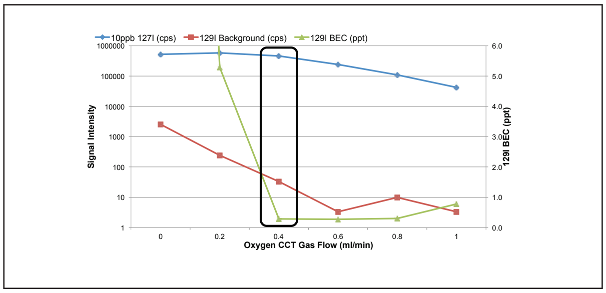

Figure 2. Comparison of different manually tuned settings for the CCT gas flow.

Conclusion

The use of the Thermo Scientific iCAP Q ICP-MS QCell technology operated in CCT mode with 100% O_2 as a reactive gas completely eliminates the isobaric Xe interferences that affects the detection of radioactive iodine isotopes. Instrument set-up and optimization is easily accomplished using the supplied generic autotune routine in the Thermo Scientific Qtegra ISDS Software.

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