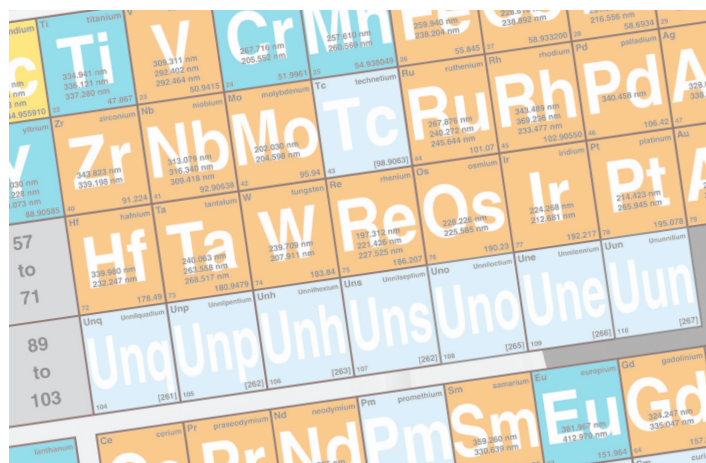


Thermo Scientific iCAP Qnova Series ICP-MS PLUS Torch for improved ICP-MS analysis of challenging samples

The Thermo Scientific™ iCAP™ Qnova Series ICP-MS instruments allow for robust and reliable analysis of almost all elements in the periodic table in a wide variety of sample matrices. In addition to the conventional quartz torch, the new optional PLUS Torch, made of high purity and high-performance ceramic materials, is now available to further improve the performance of both single and triple quadrupole ICP-MS.

The torch of an ICP-MS system is one of the most important components to assure consistent and reliable operation. Being in direct contact with the plasma and the sample aerosol generated by the nebulizer, it is exposed to heat, intense UV emission, and corrosive vapors. As part of the routine maintenance of the ICP-MS system, the torch needs to be inspected, cleaned, and potentially exchanged on a regular basis. Whereas different materials can be used for the injector tube (e.g. platinum or sapphire), torches are commonly made from high purity quartz. Over time, and especially when exposed to challenging sample types, conventional torches can devitrify, leading to the material becoming brittle and unstable, ultimately requiring an exchange.

For laboratories running samples such as brackish waters (e.g., fracking flowback solutions, produced waters, or sea water), highly acidic samples, or organic solvents



(e.g., crude oil or refined products), the torch may need to be exchanged more frequently as compared to other sample types, such as digested food materials. Issues with the torch may therefore become a significant part of the running cost and potentially be a reason for unplanned downtime.

At the same time, although made of high purity quartz, the torch may contribute to the backgrounds observed during analysis for a variety of elements, but most importantly for silicon. Silicon is a key element in a range of applications, for example monitoring of impurities in metals and metallurgical products, chemicals, crude oil and refinery products, pharmaceutical analysis, and environmental analysis.

With the PLUS Torch (Figure 1), there is a solution available to overcome these challenges. Ceramic torches are widely used with ICP-OES, such as the Thermo Scientific™ iCAP™ PRO Series ICP-OES, for the analysis of challenging samples.

The PLUS Torch has identical geometry to the iCAP Qnova Series ICP-MS standard quartz torch and can replace it in any of the following ICP-MS instruments: Thermo Scientific™ iCAP™ Q ICP-MS, Thermo Scientific™ iCAP™ RQ ICP-MS, Thermo Scientific™ iCAP™ TQe ICP-MS, and Thermo Scientific™ iCAP™ TQ ICP-MS.

It is easily mounted in the quick fit torch holder and compatible with all other components of the sample introduction system (different nebulizers or injector tubes). Tuning and performance of the instrument is not affected by replacing the quartz torch with the PLUS Torch, as highlighted by the data shown in Table 1.

Table 1. Comparison of the standard performance of an iCAP RQ ICP-MS with the PLUS Torch compared to a standard quartz torch using the standard high matrix (3.5 mm) skimmer cone insert

	Specification	Standard torch	PLUS Torch
⁷ Li [kcps/ppb]	>55	>60	>60
⁵⁹ Co [kcps/ppb]	>100	>170	>170
¹¹⁵ In [kcps/ppb]	>240	>400	>420
²³⁸ U [kcps/ppb]	>330	>395	>410
Oxides ¹⁴⁰ Ce ¹⁶ O ⁺ / ¹⁴⁰ Ce ⁺ [%]	<2	1.7	1.8
Doubly charged ¹³⁷ Ba ⁺⁺ / ¹³⁷ Ba ⁺ [%]	<3	2.5	2.3
Background <i>m/z</i> 4.5 [cps]	<1	<0.4	<0.3
Short term stability [% RSD]	<2 (10 minutes)	<0.7	<0.5
Long term stability [% RSD]	<3 (2 hours)	<1.1	<1.0



Figure 1. PLUS Torch made of high purity and high-performance ceramic materials

One element that specifically benefits from the use of alternative material for the torch is silicon. Analysis of silicon at ultra-trace levels is problematic with ICP-MS due to three main reasons:

- Abundant polyatomic interferences on the most abundant isotope ²⁸Si (predominantly ¹⁴N₂⁺)
- Additional interferences (such as ¹²C¹⁶O⁺) when analyzing organic solvents
- Potential contamination from the sample introduction system (quartz consists of pure SiO₂)

While the nitrogen-based interferences can be addressed using a collision/reaction cell (CRC) or the use of triple quadrupole ICP-MS, the backgrounds introduced by the glassware are almost impossible to avoid.

With the PLUS Torch, a significant improvement of the resulting backgrounds and, subsequently, the achievable detection limits can be observed for silicon. To demonstrate the improvement, a series of different sample types were analyzed using both a conventional torch and a PLUS Torch. The results are summarized in Table 2.

Table 2. Detection limit and blank equivalent concentration for silicon in a variety of sample types and analysis modes

	Sample type	Analysis mode	Background reduction factor	BEC [$\mu\text{g}\cdot\text{L}^{-1}$]	IDL [$\mu\text{g}\cdot\text{L}^{-1}$]
iCAP RQ ICP-MS	Aqueous, 0.5% nitric acid*	KED (^{28}Si)	>2.5	7.6	0.73
		CCT H_2 (^{28}Si)	>15	0.8	0.03
		TQ- H_2 (^{28}Si)	>15	0.6	0.01
iCAP TQ ICP-MS	0.5% H_2SO_4 **	TQ- O_2 ($^{28}\text{Si}^{16}\text{O}^+$)	>13	0.9	0.04
		TQ- O_2 ($^{28}\text{Si}^{16}\text{O}^+$)	>13	0.8	0.05
	Organic, Xylene	TQ- O_2 ($^{28}\text{Si}^{16}\text{O}_2^+$)	>20	2.7	0.41
	Organic, PGME†	TQ- O_2 ($^{28}\text{Si}^{16}\text{O}_2^+$)	>7	5.28	0.35

* Instrument equipped with quartz nebulizer, spray chamber, 2.5 mm i.d. quartz injector, and Ni cones.

** Instrument equipped with PFA micro flow nebulizer (400 $\mu\text{L}\cdot\text{min}^{-1}$ flow rate), PFA spray chamber, 2.0 mm i.d. sapphire injector and Pt tipped cones.

† Instrument equipped with PFA micro flow nebulizer (100 $\mu\text{L}\cdot\text{min}^{-1}$ flow rate), quartz spray chamber, 2.0 mm i.d. sapphire injector and Pt tipped cones with the Cold Plasma lens kit.

In all cases, the observed background on silicon was significantly reduced and detection limits could be decreased to sub $\mu\text{g}\cdot\text{L}^{-1}$. This is especially obvious with a triple quadrupole ICP-MS, where superior interference removal additionally helps to lower the background signals caused by potential interferences.

The PLUS Torch available for the iCAP Qnova Series ICP-MS systems now offers a new option to overcome challenges seen with standard quartz torches for laboratories seeking higher uptime for challenging sample types or better analytical performance.

- Direct replacement for standard quartz torch with comparable standard performance
- Improved lifetime and reduced maintenance for high matrix samples
- Reduced backgrounds and improved detection limits for silicon



Figure 2. Conventional quartz torch and the new optional PLUS Torch for iCAP Qnova Series ICP-MS instruments

Find out more at thermofisher.com/ICP-MS

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