

Vacuum & Optical Technologies for ICP-OES

Broad product portfolio of reliable, innovative solutions for your most challenging Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) applications

Introduction

ICP-OES, also known as ICP-AES (Atomic Emission Spectroscopy), is a widely used analytical technique for trace element analysis in predominantly water-dissolved samples; capable of measuring a majority of the elements in the periodic table. This technique was first devised in the early 1970s and now boasts an install base of more than 50,000 units. It is a type of emission spectroscopy that uses an Inductively Coupled Plasma (ICP) to excite the sample to produce ions that emit electromagnetic radiation at wavelengths characteristic of particular elements in the sample. The intensity of this emission is indicative of the concentration of the element within the sample. ICP-OES, a very versatile technique, allows reliable, simultaneous, and sequential analysis of multiple elements. Its stability offers high sensitivity and low limits for detection of a majority of elements.

The ICP-OES instrument has two main subsystems – the ICP and the optical spectrometer. In the ICP subsystem, a precisely controlled amount of Argon gas supplied to a torch coil is ionized, generating plasma. The optical subsystem consists of a light source, a spectrophotometer and a detector. As the electrons are excited by the extreme heat of the plasma (up to 7,000K), they reach an excited energy state. When they drop back to ground energy level, some energy is emitted as photons. By means of sophisticated optics that include diffraction gratings, filters, mirrors, and prism assemblies, the emitted photons in various frequencies are captured on a CCD detector.

Advanced mass flow controllers are required to let only pre-determined amounts of plasma gas, nebulizer, and other gases into the system. Stable gas delivery is critical for plasma stability regardless of changes in atmospheric conditions. Diffraction gratings, specifically echelle gratings that are widely used in ICP-OES systems are the heart of the optical subsystem. Low quality gratings and optical components could compromise the wavefront, efficiency, and scattering characteristics of the optical system, adversely affecting spectral resolution and instrument sensitivity. Proper layout of the optical subsystem ensures high efficiency light transmission and superior resolution.

Solving key challenges in ICP-OES

- Gas Flow Measurement & Control
- Diffraction Gratings
- Custom Vacuum Machining
- Integrated Optical Subassemblies
- Vibration Isolation Systems
- Optical Components

New Challenges in ICP-OES



Modern day ICP-OES systems are the workhorse of trace elemental analysis with applications spanning industries such as environmental analysis, metallurgy, and food and beverage. This requires the systems to be robust, reliable, accurate, and stable. Customers are increasingly using these instruments for high-throughput applications that require quick analysis time and the shortest instrument downtime. In addition, they must also take proper care in sample preparation to minimize any matrix interferences. ICP-OES systems continue to evolve in their usage and application to address today's most pressing challenges:

- Higher productivity through higher sample throughput and simplified maintenance
- Reduced gas consumption to lower overall sample costs
- Higher sensitivity — lower and lower limits of detection
- Smarter instruments with sophisticated software and intuitive, walk-up operation

As ICP-OES systems gain traction in the pharmaceutical and nutraceutical industries, they must meet stringent regulatory and enhanced security requirements including software audit trails.

With the advent of smart devices, customers are increasingly driving manufacturers to provide remote diagnostic services.



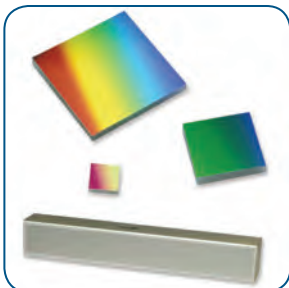
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MKS Solutions



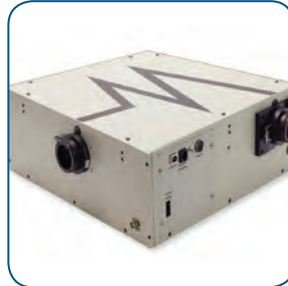
The quality of gas mass flow controllers (MFCs) used in ICP-OES systems can directly affect plasma stability and, in turn, instrument lifetime. Superior quality MFCs ensure a precise, stable, and repeatable flow of gases into the system across the full range of flow rates. MKS proprietary control algorithms provide fast and repeatable

response to set points throughout the device control range. MKS MFCs feature a multi-gas, multi-range capability, remote access for real-time monitoring, and elastomer and metal seal options. These MFCs are clean-room manufactured to eliminate sample contamination during analysis.



The diffraction gratings, usually echelle gratings, in the ICP-OES system provide wavelength separation and identification of trace elements within the sample. The quality of the gratings has a direct impact on the sensitivity and spectral resolution of the instrument. Superior quality gratings have high spectral resolution,

dispersion, and efficiency. As the author of "Diffraction Grating Handbook", widely considered the bible of diffraction gratings, MKS prides itself on exceptional quality, design and applications expertise, and unparalleled precision and performance. The MKS gratings portfolio includes a wide variety of echelle gratings as well as standard ruled and holographic gratings in a wide variety of sizes, groove spacings and blaze angles, coating and substrate materials. MKS also customizes gratings for OEM applications. With thousands of masters in stock and in-house engineering teams, MKS partners with customers through all stages of the product development process to meet their unique requirements.



The spectrograph is a complete optical spectroscopy system offered by MKS. The optical design of the MKS family of spectrographs is based upon an asymmetrical in-plane Czerny-Turner monochromator. The spectrograph produces a flat image plane for use with multichannel detectors.

Toroidal mirrors are used to produce accurate images of the input slit in the flat output plate. The optical configuration is designed to ensure high resolution and maximum throughput. The MKS spectrograph is optimized to provide excellent stray light rejection while minimizing aberrations. Spatial and spectral resolution are measured independently and optimized during the instrument calibration process. The exceptional flat field and minimal optical aberrations of the spectrograph mean that the resolution is very nearly constant across the entire focal plane. Its versatility, performance, small size, and simple design make it ideally suited for research applications and custom configurations for OEM applications.



The optical sub-assembly within the ICP-OES system that includes precisely placed and spaced optics – lenses, mirrors, mounts, etc. is one of the most critical parts of the instrument. Depending on instrument complexity and customer requirements, a completely holistic optical system design is often required. The design includes

challenges such as mounting all the components in a small area, proper alignment, and calibration. The MKS Integrated Solutions Business unit provides expert design and consulting services for the most complex of designs. With over 50 years of optics design and applications experience in diverse markets, MKS provides world-class system design backed by a global network of sales, service, and support centers in over 30 countries worldwide including manufacturing capabilities in Asia and Central America.

MKS is a leading global provider of optics and vacuum technology products for analytical instrumentation manufacturing, medical equipment manufacturing, research laboratories, semiconductor, and other advanced manufacturing applications. We are committed to helping our customers solve their most complex problems. For further information visit us on the web at www.mksinst.com or call us at 978-645-5500.

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