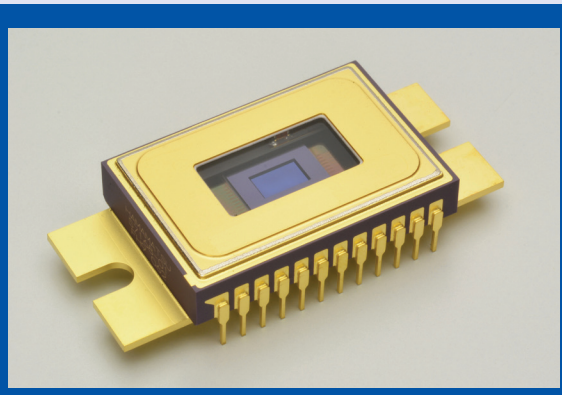
TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Avio 220 Max ICP-OES Custom-Designed Solid-State Detector with Hybrid Simultaneous Analysis



ICP-OES spectrometers have traditionally been limited by their inability to make background correction measurements simultaneously with the analyte measurement. If there is any variation in the analytical conditions between the two different measurement times, analytical precision may be degraded. However, in the Avio® 220 Max hybrid simultaneous ICP-OES, the dual backside illuminated charge-coupled device (DBI-CCD) detector simultaneously measures a wavelength range around the analytical wavelength (within a given CCD array), including the background correction wavelength(s). In the Avio 220 Max, background correction readings are made at exactly the same time as analyte measurements with significant improvements in analytical accuracy (Figure 1).

Exceptional Design for Superior Quantum Efficiency and Maximum Performance

The Avio 220 Max ICP-OES uses a large area, dual backside-illuminated charge-coupled device (DBI-CCD) detector measuring 3 by 5.5 mm with two independent arrays, each with 176 by 64 pixels (Figure 2). The detector is a backside-thinned CCD array, where the detector chip is thinned to a few microns and illuminated from the rear. This prevents absorption by control gates and maximizes quantum efficiency without the use of a fluorescent coating. The result is exceptional quantum efficiency over the entire wavelength range, particularly at the lower UV wavelengths (Figure 3). Plus, the large active area of the detector allows the use of a more efficient optical system for exceptional analytical performance.

The detector is divided into two segments – one for the analytical measurement and a second to continuously monitor a reference spectrum.

Key Benefits

- Simultaneous background correction further improves analytical accuracy and detection limits
- Superior quantum efficiency delivers enhanced analytical performance and superior detection limits
- Dynamic wavelength stabilization increases analytical reproducibility and reliability

Dynamic Wavelength Stabilization

With its unique CCD design, the Avio 220 Max ICP-OES provides exceptionally fast, accurate wavelength setting. Of course, the exact assignment of wavelengths to intensities is crucial to the accuracy and reproducibility of optical emission measurements. The unique design of the Avio 220 Max optical system allows for the use of shorter focal lengths while maintaining high resolution. Thermal effects are minimized by using short focal lengths, eliminating one of the major sources of wavelength error. And to virtually eliminate the effects of wavelength drift, the Avio 220 Max ICP-OES features dynamic wavelength stabilization (DWS). DWS actively corrects for any residual spectral shifts. A reference spectrum from a low pressure neon discharge lamp is transferred directly to the intermediate slit using a fiber optic. The Echelle monochromator disperses the neon spectrum, with all orders superimposed on the exit plane (the detector) to create a well-defined wavelength pattern at each position of the grating. The top portion of the DBI-CCD detector is dedicated

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to continuously monitoring and recording this spectrum, effectively appending a wavelength calibration scale to each analytical reading. Wavelength calibration is checked with each and every reading, and any necessary corrections are made automatically without operator intervention. This real-time wavelength monitoring system produces exceptional stability (Figure 4), while allowing plug and play of the Avio 220 Max from cold start to sample analysis in 10 minutes.

Cost-efficient Peltier Cooling

To provide the required high analytical stability and low detector "noise," the temperature of the solid-state detector has to be precisely maintained. In the Avio 220 Max ICP-OES, a single-stage Peltier cooling plate on the detector mount effectively removes the heat from the detector. Since this cooling plate is large compared to the size of the detector, near-perfect temperature stability at the detector is achieved without the need of a more expensive multi-stage cooling system. The Peltier element is integrated into the package so that only the low-mass chip is cooling, eliminating the need for cooling water. The detector housing is hermetically sealed and is filled with dry nitrogen to eliminate condensation.

Together, the superior quantum efficiency, simultaneous background correction and dynamic wavelength stabilization of the Avio 220 Max ICP-OES delivers exceptional accuracy, reproducibility, reliability and detection limits.

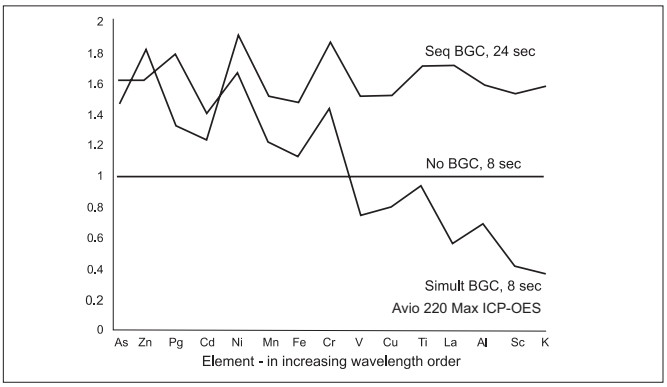

Figure 1. The effect of simulaneous background correction on detection limits. Relative detection limits have been normalized to results with no background correction. Note the significant improvement in detection limits at longer wavelengths with simultaneous background correction.

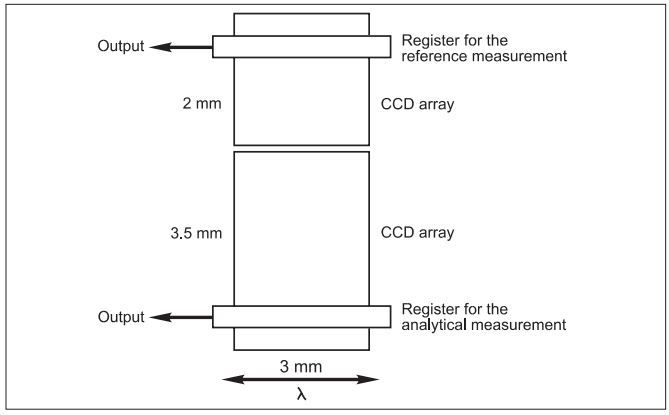

Figure 2. Simplified drawing of the Avio 220 Max DBI-CCD.

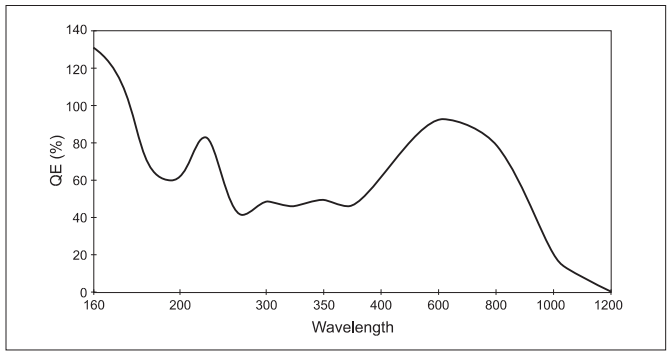

Figure 3. DBI-CCD quantum efficiency. The actual quantum efficiency of this detector is 60-80% in the UV range and up to 100% in the visible range, making it superior to other detectors on the market.

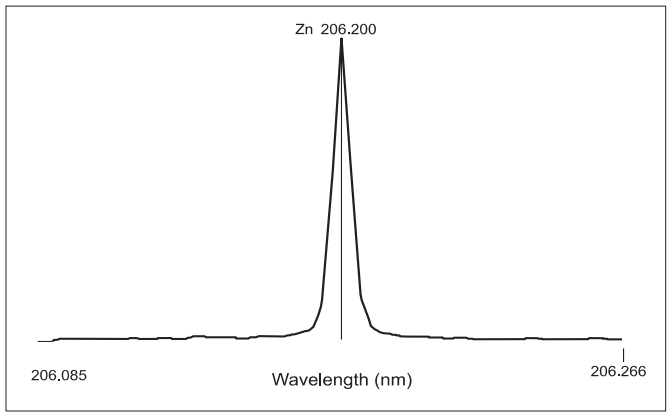

Figure 4. Overlay of 60 consecutive measurements over 20 hours with temperature varying from 10-35 °C, demonstrating superior wavelength stability provided by dynamic wavelength stabilization.

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