TECHNICAL NOTE

ICP-Optical Emission Spectroscopy

Optima 8300 ICP-OES Optical System and SCD Detector

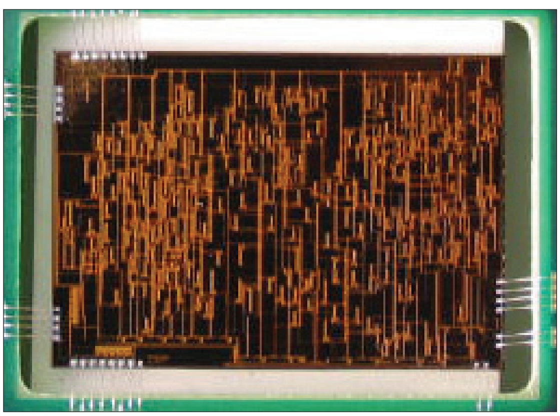

Figure 1. The Optima 8300 SCD mounted on a Peltier cooler.

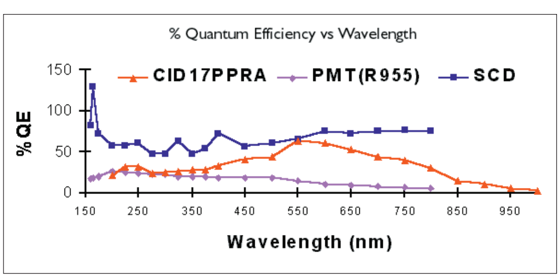

Figure 2. SCD quantum efficiency.

The optimized optical system of the Optima™ 8300 ICP-OES centers on a unique high-performance solid-state detector – the Segmented-array Charge-coupled Device (SCD) detector. A new echelle-based polychromator was designed in order to fully utilize the capabilities of the SCD. Using a PerkinElmer® echelle grating optimized for UV performance and a unique Schmidt cross-disperser grating, the Optima 8300 optical system has exceptional optical throughput and excellent resolution, providing you with superior detection limits and line selection.

Why an SCD? Flexibility, simultaneity and low noise

Offering the flexibility of thousands of emission lines with simultaneous background measurement would have been an impossible task with photomultiplier tube technology. So our engineers literally invented new detector technology. The patented SCD (Figure 1) was designed by PerkinElmer. It has been created specifically for plasma emission spectroscopy.

Superb UV quantum efficiency (Figure 2), dynamic range, and negligible read-out noise make it the ideal detector for the ideal spectrometer, and being solid-state, it offers exceptional long-term performance and reliability. Each silicon-based detector consists of hundreds of discreet subarrays which have from 20 to 80 photosensitive areas or "pixels" per subarray. The subarrays are strategically placed to take advantage of the best emission lines for all of the elements. The position and size of each subarray have been engineered carefully to match each wavelength order produced by the echelle polychromator.

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On the detector next to each subarray (Figure 3) are the output electronics for that subarray. Since the electronics are immediately adjacent to the subarray, the readout noise is extremely low, much lower than any other charge transfer device. There is no need for time-consuming multiple readouts to reduce detector noise. Also, each subarray can be individually addressed through the interface logic next to it. This means that you can read any subarray without the necessity of reading out an entire detector, thus saving you time.

The SCD detector, unlike many Charge-Coupled Devices (CCDs), has been designed to prevent charge "blooming." "Blooming" occurs when a pixel fills up with electrons and the excess electrons spill into an adjacent pixel, much like an overfilled bucket. Should a pixel on the SCD exceed its capacity during an integration, the excess electrons flow into the output register where they are electronically swept away. For secondary protection, there is also a guard band surrounding each subarray. This anti-blooming design helps to ensure the integrity of your results.

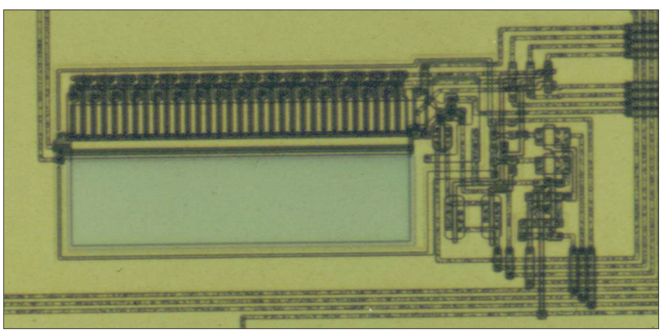

Figure 3. Drawing of a single subarray from the SCD.

The subarrays see different portions of the wavelength spectrum at the same time, allowing simultaneous measurement of thousands of emission and background wavelengths. The peak emission and the spectral background are measured simultaneously (with user-selectable background parameters), reducing data-acquisition time and increasing your sample throughput. Analytical precision and detection limits are also improved, since simultaneous measurement of analyte and background can compensate for signal variations attributable to the sampling system.

The Optima 8300 ICP-OES optical system

Energy from the plasma enters the spectrometer and is focused on the entrance slit by the torroidal mirrors (Figure 4). The first mirror is computer-controlled and can be automatically positioned to optimize both the plasma viewing height and lateral position. The second torroidal mirror directs the plasma energy to the entrance slit. The parabolic mirror, after the slit, collimates the energy onto the echelle grating, which separates the light into high dispersion, overlapping orders.

The next optical component, the Schmidt cross-disperser, serves three purposes. First, with dual-detector configurations, a hole in the center of the optic is used to split the light into separate UV and visible channels. Light passing through the hole is dispersed by the prism and is focused onto the surface of the visible wavelength detector. The energy reflected off the surface of the cross-disperser is sent through the UV channel. The use of separate UV and visible channels effectively doubles the detector area. It also ensures that there are no compromises in spectral range, resolution or energy throughput and that analyses at all wavelengths can be performed simultaneously.

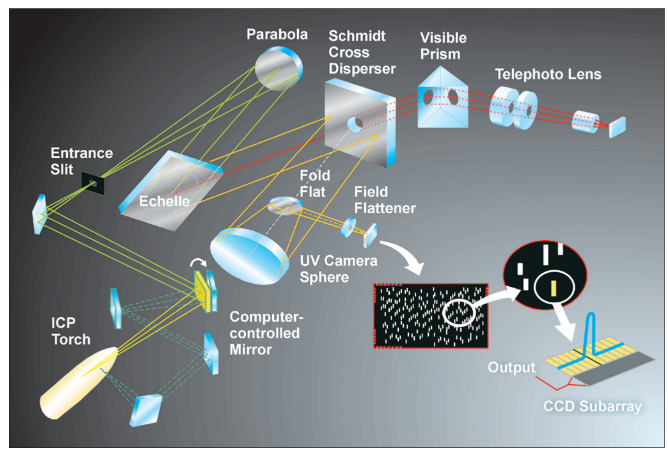

Figure 4. Optima 8300 optical diagram.

The second purpose of the Schmidt cross-disperser is to serve as a grating that separates the light by order. The dispersed light is sent to the camera sphere and then onto the UV wavelength detector via the fold flat mirror, the size and shape of which are matched to the hole in the cross-disperser so that no energy is lost.

The third use of the Schmidt cross-disperser is to optically correct for spherical aberrations, distortions of the optical image. By correcting for these aberrations, the Optima spectrometer produces clean, sharp images at the detector for highest resolution (Figure 5). To provide long-term stability, the entire Optima 8300 optical system is enclosed in a thermostatted housing. This isolates the optical system from the ambient environment and ensures exceptional wavelength stability. Better stability means better productivity, because less time is required for recalibration.

Better answers faster

Even if you don't need to reach the trace detection limits that the Optima 8300 ICP-OES can provide, that power translates into improved precision, accuracy and speed, supplying clearly better analytical results, faster. Plus, you can be assured that if your requirements change, you have a system that has the ability to grow with you.

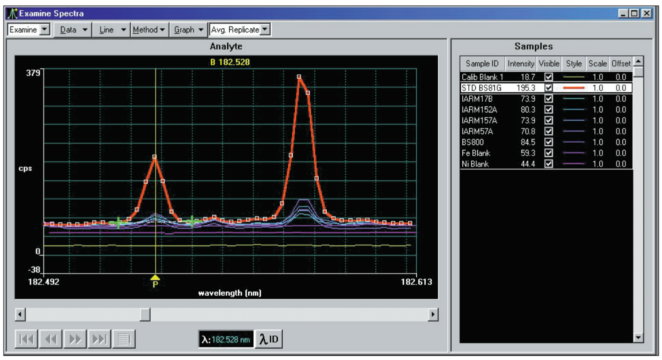

Figure 5. The superb resolution of the Optima 8300 ICP-OES is shown by the separation of the boron doublet at 182.5 nm.

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