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Four Things to Know about Advanced Scintillation Gamma-Ray Sensors

By Kevin McKinney and Eric Rothe

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Directional drilling in upstream oil and gas exploration relies on powerful detection solutions that will withstand the harshest of environments. Conditions include high temperatures, shock, and vibration; all of which can hinder the effective use of gamma ray sensors for density, spectroscopy and passive gamma applications.

Since the gamma-ray sensor moved from Geiger-Mueller tubes to solid state scintillation crystals, Sodium Iodide (NaI) crystals have dominated the sector. The sensor's NaI crystal absorbs gamma radiation and emits a burst of light. A photomultiplier tube (PMT) collects that burst of light and turns it into a signal, which the detector's electronics grab and store for transmission.

Over the years, gamma sensor manufacturers, including Reuter-Stokes, have continuously optimized these tools for higher light output, energy resolution and sensitivity. However, the drilling landscape has changed over the past 50 years and new challenges are emerging, particularly in North America.

Limitations of Sodium Iodide gamma sensors include light loss at elevated temperatures, mediocre spectral resolution, and slow pulse-response time. It has long become apparent that both wireline and drilling applications could benefit from a more powerful crystal technology. The industry needs better, more sensitive sensors.

1) Why do we need better gamma-ray scintillators?

Whether drilling onshore or offshore, drilling crews need to be able to go deeper, faster, and longer while maintaining a pinpoint wellbore placement. This means the downhole equipment will be subjected to harsher environments with increased performance requirements. And the limitations of Sodium Iodide crystals may not be enough to meet the challenges ahead.

Enter new gamma-ray crystal materials development. Combinations of Cerium, Lanthanum, Bromine, Chlorine and Iodine are common targets for those pursuing new scintillators for these applications. And at Reuter-Stokes, we have developed Lanthanum Halide (LaHa) and Cerium Bromide (CeBr) formulations that we believe can provide superior performance while operating accurately and reliably in the harshest environments.

2) What are the benefits of these new materials?

Lanthanum Halide and Cerium Bromide offer marked improvement over Sodium Iodide in nearly every performance benchmark. The increased density and atomic number of these materials relative to Sodium Iodide result in a significant increase in sensitivity (+40%). Better sensitivity enables the sensors to deliver higher light output for better spectral resolution and have a longer lifespan.

Improved energy resolution delivers faster data acquisition with more accurate spectroscopic measurements. With a half-life of about 18 nanoseconds for Lanthanum Halide and Cerium Bromide crystals versus 200 nanoseconds for Sodium Iodide, these new materials significantly improve performance in higher count rate applications such as pulsed-neutron spectrum measurements.

Higher light output lengthens the detector's lifespan by reducing high-voltage requirements. In counting applications, this means longer plateaus to provide more stable count rates over the detector's operating temperature range for better spectral resolutions and longer life.

3) What is the difference between Lanthanum Halide and Cerium Bromide crystals?

Advanced scintillator performance depends on several factors, including the crystal's size and aspect ratio of the crystal, optical interfaces' design and construction and various mechanical interfaces. And we have discussed how these new materials provide superior sensitivity, spectral resolution, and count-rate capacity over Sodium Iodide crystals. But what are the differences between the Lanthanum Halide and Cerium Bromide crystals?

Lanthanum Halide offers better light output and better pulse height resolution than both Cerium Bromide and Sodium Iodide. However, Lanthanum has a naturally occurring radioactive lanthanum isotope close to that of Potassium that can contribute to background radiation.

Though it does not have the performance capabilities of Lanthanum Halide, background radiation is not an issue for Cerium Bromide. And it still maintains a performance advantage over Sodium Iodide. Inevitably, your application will drive which detector to use and you will want to pick the crystal that gives you the best data for your needs.

4) When will these new advanced scintillation gamma-ray sensors be available?

At Reuter-Stokes, we have been finalizing the development of our advanced scintillators containing Lanthanum Halide and Cerium Bromide for both drilling and wireline applications in partnership with a world-class crystal grower.

And we have recently announced the commercial release of select sizes of the Lanthanum Halide and Cerium Bromide for directional drilling applications.

We are continuing to develop additional sizes for both drilling and wireline applications. In the meantime, if you have a particular requirement please feel free to reach out to us and we will be happy to discuss.

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