Shining Light on Graphite Purity

Application Note

KEYWORDS

- Graphite
- Lithium-ion batteries
- HR2 high-resolution spectrometer

TECHNIQUES

- Reflectance

APPLICATIONS

- Quality control
- High-volume production monitoring

In this application note, we use a compact, high-resolution spectrometer to investigate the reflectance properties of graphite samples in powder form. Despite their black color, graphite samples reveal important spectral differences, most notably in the UV region.

With more Internet-connected devices on earth than people **(1)** and considering electric vehicles hit the 10% mark for global auto sales in 2022 **(2)**, the use of lithium-ion batteries is more important than ever and requires intelligent solutions to improve manufacturing efficiency and environmental impact.

One of the most important components in the anode material of lithium-ion batteries is common graphite, similar to what is used in a pencil. However, because impurities and carbon defects can be a major hurdle in optimizing battery performance, manufacturers need fast and repeatable methods to grade incoming graphite and to monitor graphite quality after it has gone through some refining processes **(3)**.

Spectroscopy for Graphite Analysis

Spectroscopy offers one method of rapid graphite quality testing, although initially, this may seem difficult for a material that appears pitch-black and difficult to differentiate by sight. But that is merely

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a limitation of our human eyes; by leveraging spectral activities in the UV region we can observe clear differences between pure graphite and samples containing silica and general "dirt" impurities.

We took a sample of pure flake graphite (0.5 µm, 99% carbon) and mixed in small amounts of common silica or dirt, and then tested the samples using a reflection probe to check for spectral differences **(Figure 1)**.

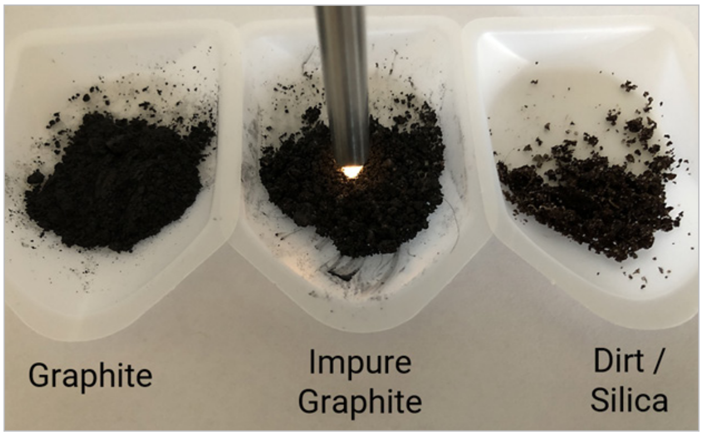

Figure 1. Graphite samples were measured using a 6-around-1 fiber optic reflection/backscatter probe, which is ideal for specular or diffuse reflectance from solids.

Using a setup comprising an Ocean HR2 UV-vis spectrometer, DH-2000-BAL deuterium-tungsten halogen broadband light source and a reflection probe, we first established the pure graphite sample as our 100% reflectance reference and then compared the reflectance of the other samples to the reference **(Figure 2)**.

Although it may seem counter-intuitive to use a black sample as our reflection standard, the pure graphite actually provides greater UV reflection than the dirt/silica sample does. This underscores the value of being able to "see" non-visible wavelengths for spectral response that otherwise would remain hidden. We can use this spectral platform to ensure samples remain as close as possible to the 100% reflectance line for pure graphite.

Summary

The ability to detect spectral variations in the UV region and distinguish ultra-pure graphite from impurities – and to acquire these readings in less than 1 second – suggests a high-resolution, high speed spectrometer like the Ocean HR2 would be a valuable tool to integrate into high-volume production of graphite materials targeted for lithium-ion batteries and other electronic devices. For example, the ability to monitor high sample volumes will be critical for operations such as battery manufacturer EcoGraf's new facility in Western Australia (along with a similar facility planned for Europe) that will produce 20,000-tons of graphite per year **(4)**.

Are you working in the realm of personal electronic devices or electric cars? Do you have a need for rapidly monitoring raw or post-process materials for potential impurities? If so, reach out today to tell us what you're working on and learn how compact spectroscopy solutions combined with years of know-how can help elevate your QC technologies into the 21st century.

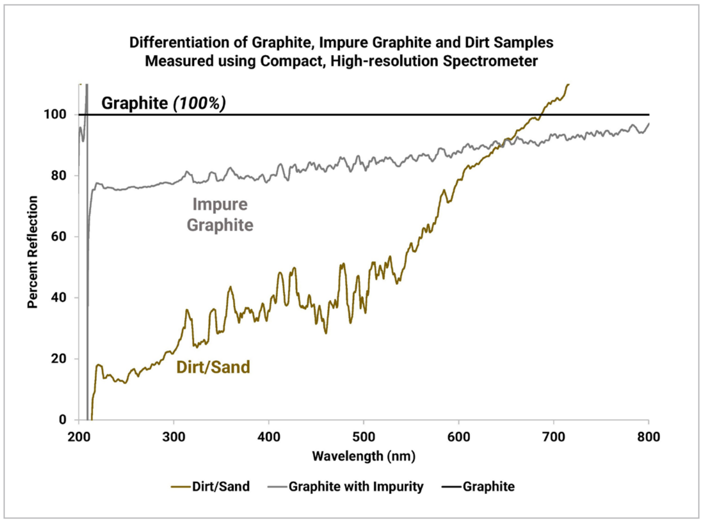

Figure 2. Although our test samples appear nearly identical visually, this spectral snapshot reveals significant spectral reflectance differences in comparison to a pure graphite reference.

References

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