HAIP Solutions

APPLICATION NOTE

BlackIndustry SWIR 1.7 Pro Max
Sorting Industrial Minerals
Case Study: Calcites

1. Introduction

Natural minerals are finite goods on Earth. Nonetheless, the demand of minerals for the construction industry, the manufacture of technical equipment, chemicals and much more is constantly increasing. Therefore, sensor-based sorting of resources is increasingly being used especially for industrial materials. Alongside X-ray , color- or LIBS-based sorting, this also includes hyperspectral-based sorting, also known as NIR-based spectrometry in the industry.

The purpose of these techniques is to enable the most sustainable and resource-efficient extraction of industrial minerals possible by maximizing the potential of the mining sites and processing as well as transporting as little unwanted material as possible over long distances. Moreover, it is reported that up to 30% of the water required for processing can already be saved if sensor-based sorting of the raw materials is used (Sharma, 2023).

2. Industrial Minerals: Calcites

Calcite, also known as calcium carbonate, is a naturally occurring mineral composed of calcium, carbon, and oxygen ($CaCO_3$). It is found in rocks such as limestone, marble, and chalk, making it one of the most abundant minerals on Earth. Its versatility and chemical stability make it essential in industries ranging from construction and manufacturing to healthcare and environmental applications.

- **Construction**: A primary ingredient in cement, concrete and lime production.
- **Plastic Industry:** Used as a filler to improve durability and reduce costs.
- **Paints and Coatings**: Enhances opacity and brightness while maintaining stability.
- **Pharmaceuticals**: Acts as a calcium supplement and antacid.
- **Environmental Management:** Utilized in flue gas desulfurization and water treatment processes.
- **Paper Industry**: Improves paper quality by increasing whiteness and smoothness

The global calcite market was estimated to be worth around USD $25 billion in 2023. Prices are expected to rise as demand for calcite continues to increase, particularly in the construction, paper and plastics industries (Sudarshangroup, 2024). Simultaneously, the purity of calcite has a significant impact on the price, making it particularly important in calcite mining.

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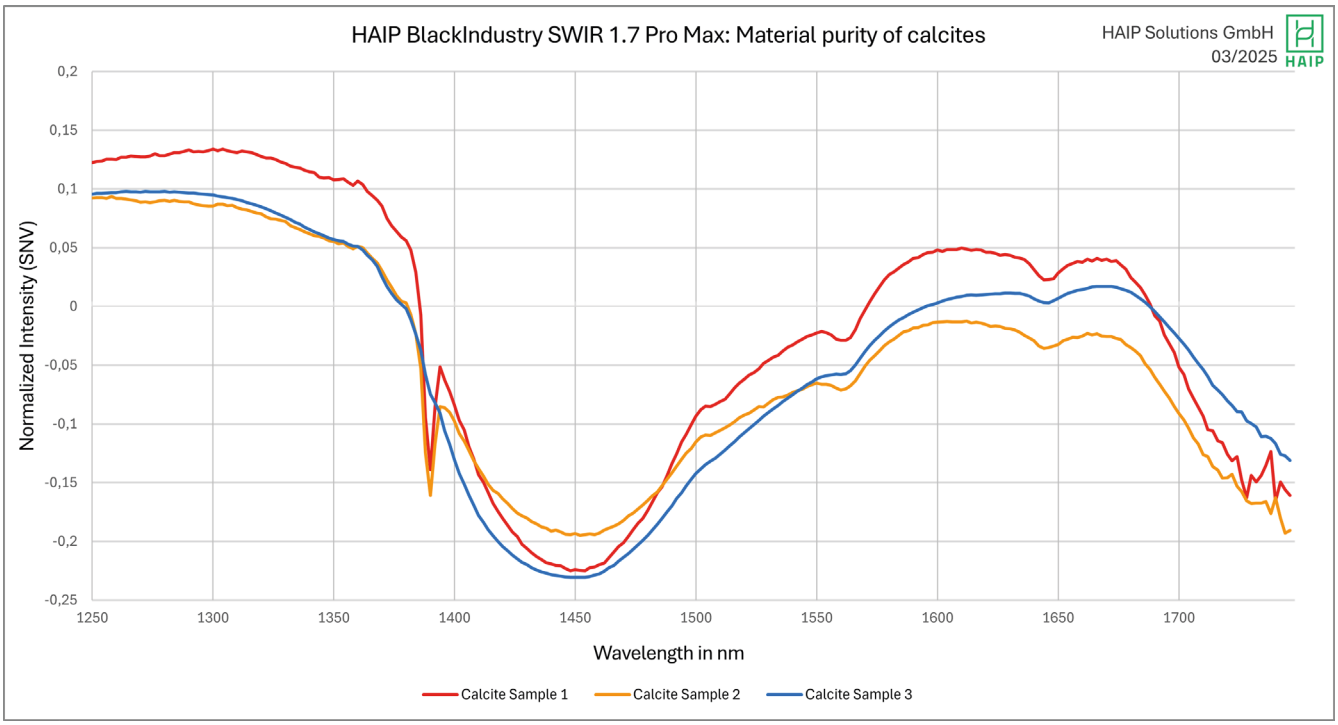
Concerning the hyperspectral analysis of calcites, it is generally known that the most important absorption band of calcites is at approximately 2335 nm and that there are up to 7 absorption bands between 1600 nm and 2550 nm in carbonate minerals (Corlett et al., 2021). Until now, very expensive, technically error-prone hyperspectral cameras have been needed to examine such wavelength ranges. Our SWIR camera poses an answer to those problems.

3. The Ultimate Solution: HAIP BlackIndustry SWIR 1.7 Pro Max

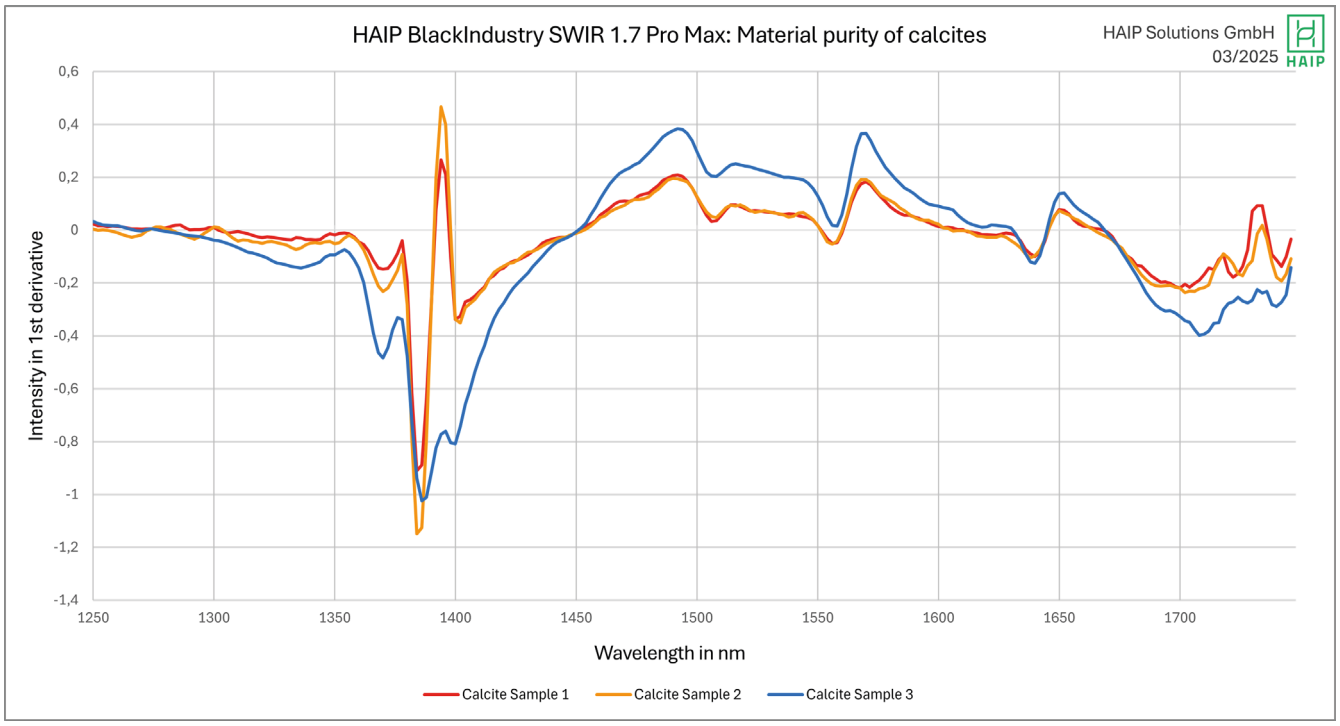
HAIP Blackindustry SWIR 1.7 Pro Max

- Spectral range: 900 – 1730 nm
- Spectral resolution (FWHM): <3 nm
- Spatial resolution: 2560 px
- Frame rate: Up to 2230 Hz

4. Case Study: Determining Material Purity of Calcites



Spectral Intensity of different calcite samples, Standard Normal Variate (SNV);
Data acquired using HAIP BlackIndustry SWIR 1.7 Pro Max



Spectral Intensity of different calcite samples in 1st derivative;
Data acquired using HAIP BlackIndustry SWIR 1.7 Pro Max

A case study was conducted in which the material purity of calcite samples was analyzed using the BlackIndustry SWIR 1.7 Pro Max camera by HAIP Solutions. A 5 µm entrance slit was implemented for this, which enables pixel sampling of up to 0.96 nm/pixel. Combined with the extremely high spatial resolution of the camera, the spectral details of the calcite samples can now be used for optical sorting applications, which was previously not possible with existing hyperspectral cameras in the range up to 1700 nm. The absorption bands of calcite are clearly visible at ~1510 nm and ~1640 nm. The purity degrees of the minerals can therefore be distinctly identified, as can be observed in the false color display of the samples - entirely without prohibitively expensive hyperspectral cameras until 2500 nm.

False colour display of calcite samples with ROI markers; acquired with BlackIndustry SWIR 1.7 Pro Max

RGB image of calcite samples; acquired with iPhone 15 Pro

References

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