# TECH SPOTLIGHT

# Advanced Imaging Technologies

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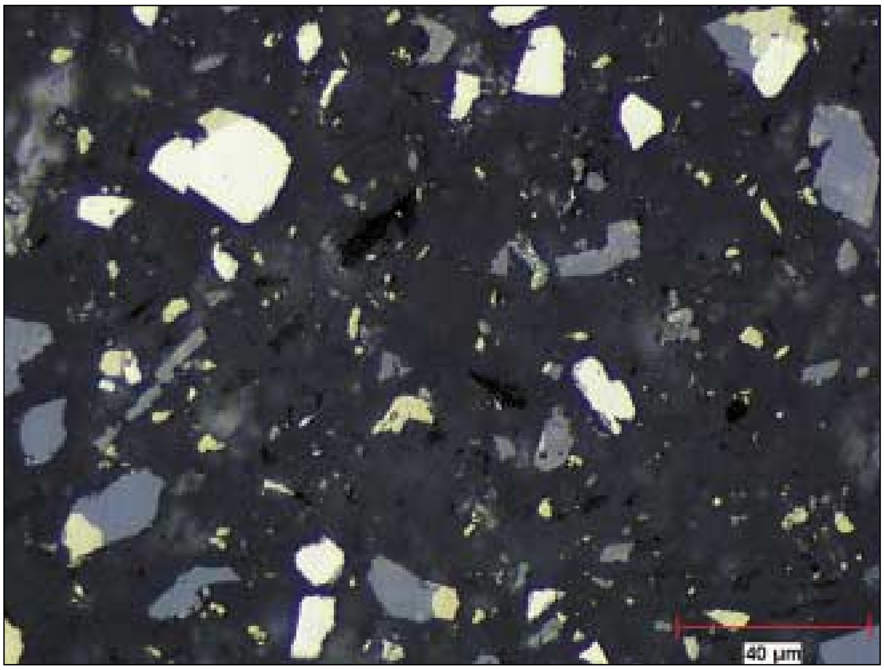



*This polished section of a flotation concentrate allows mineralogists to identify sphalerite (gray) and chalcopyrite (gold), and measure the area and liberation percentages.*

How does a lab effectively analyze the morphological characteristics of its samples? How can repeatable results be extracted time and time again? Is it possible to increase throughput without compromising statistical accuracy?

In the past, metallurgical laboratories have relied on operators who peer into microscopes and compare what they see with standard industry charts, or manually count the characteristics of a given sample. However, because these manual methods are susceptible to operator fatigue that can easily result in errors, metallurgical labs are now automating the process with image analysis systems. Automation is accelerating because reasonably priced, integrated imaging systems are now available around the world.

This article profiles two examples of leading industry players who have successfully implemented such systems: SGS-Lakefield Research, a gold mining consulting company; and The Boeing Company.

**Hunting for gold**

In the highly speculative world of gold mining, reducing costs and enhancing recoveries are major components in gaining an edge in the marketplace. SGS-Lakefield Research, Lakefield, Ontario, an established worldwide testing and consulting organization, assists the mining industry in developing extraction and processing techniques with its state-of-the-art analytical, mineralogical, and mineral processing facilities.

Mineralogists combine petrographic, image analysis, scanning electron microprobe, and QEM*SCAN technologies to investigate ore liberation and recovery. Important components in the arsenal are sophisticated image analysis hardware and software that revolutionize the way in which the morphological characteristics of samples are analyzed.

Automated image analysis offers significant advantages over manual procedures, as it eliminates approximations and generates operator-independent statistics. By combining a high-powered personal computer, advanced image analysis software, a high-resolution digital camera, and a motorized microscope stage, accurate data can be extracted on a consistent basis. The technology also reduces the need for time-consuming and repetitive searches.

Traditionally, mineralogists had to painstakingly inspect samples with a petrographic microscope to measure gold quantities, but image analysis allows this process to be automated. Before the analysis begins, samples typically undergo a number of preparation steps, including sectioning, mounting, grinding, and polishing. Samples are then placed on the motorized stage for inspection. Either a pre-established or custom designed image analysis routine then executes a list of sequential instructions to extract the needed data and related statistics.

A standard routine includes three distinct categories of instructions: image acquisition, processing, and measurement. For this purpose, a Sony DXC-950P high-resolution camera is mounted on a Nikon Optiphot 150 microscope, and images are acquired with Clemex Vision image analysis software.

To acquire images, project mineralogist Geoff Lane designed a routine that first binarizes the image by means of color threshold techniques to separate the gold from the rest of the image. Subsequent instructions then automatically remove unnecessary artifacts.

Following these steps, a special "guard frame" instruction is inserted to catch partial grains, which might fall on the edge of each field. Partial grains are virtually reconstructed at the end of the routine, at which point this data is included in the results.

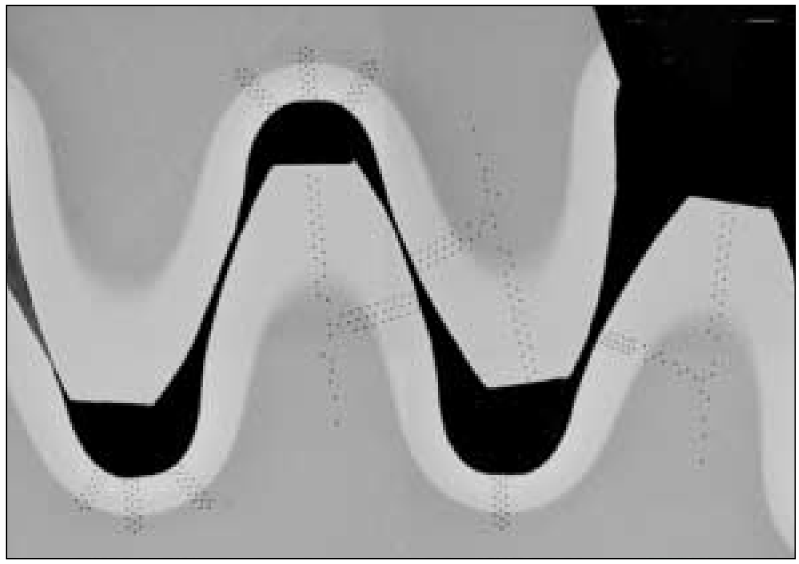
The next step is to insert measurement instructions to determine grain size length, width, feret (length measured at different angles) average, and area. These steps complete the routine, and data is then presented in a spreadsheet-like data browser with summary statistics displayed in a histogram.

For example, to scan a one-inch sample and keep track of the location of each grain, the routine is run repeatedly on hundreds of linked fields on the motorized stage. Should possible anomalies be identified when evaluating the raw data at the end of the run, operators double-click the statistic in the data browser. This procedure automatically moves the motorized stage to the field in which the irregular grain is located, at which point deletions are made. Once deleted, statistics are automatically recalculated.

To get an accurate gold grain count in a polished section, about 2500 to 5000 fields are analyzed at a magnification of about 200X. The image analysis system enables speedy, accurate, and repeatable data not previously possible.

**Imaging gears**

Gears are tested for microhardness to verify that they have been correctly heat treated at The Boeing Company, Portland, Oregon. The purpose of the test is to gage the resistance to penetration or permanent deformation of the material. Historically, to evaluate microhardness, an extensive, labor-intensive procedure had to be followed to extract HK and HV statistical results.



*The automated procedure for evaluating a gear's correct heat treatment requires only three steps, compared with the 15 steps required for the traditional method.*

After preparation of a sample, technicians would typically set the sample in the vise secured by the stage. They would then manually adjust magnification, illumination, location, and load parameters. The load would be applied, and the turret would be repositioned to a higher objective. At that point, measures would be transcribed so that hardness values could be calculated according to ASTM E 384 standards.

Highly susceptible to operator fatigue that could lead to errors, this process has since been replaced with a fully integrated, automated microhardness testing system. Part of the system consists of a hardness testing machine, motorized turret, motorized stage, and focus motor. An indenter, objectives, and a built-in camera are also included, along with powerful Clemex CMT software.

The traditional method may require in excess of fifteen steps, but the automated procedure requires only three. Operators simply position the sample in the self-leveling vise. They need not be concerned with orientation, because the software's T-Bar rotation tool allows for the setting of stage patterns at any angle. Next, multiple stage patterns are established, or preloaded from a previous session.

In the specific case of the gears, the first step is to move and locate each origin on the designated pitch line, tip, and root radius. In the second step, the pattern is rotated and aligned to be perpendicular to the surface. Clicking on the "Run" icon then launches the test.

At this point, the system dynamically follows a predefined pattern, focuses automatically when needed, makes indents, and calculates hardness values instantaneously. Follow-ing analysis, the operator can review the data in tabular or raw data format, which may then be exported to a third-party statistical package. For the gears, multiple complex patterns are sequentially processed in a single session.

Upon review of statistical data, operators have the option to re-evaluate individual indents by clicking on the numbered impression in the results window. Once selected, the system's motorized stage moves to the appropriate location. Indents may then be excluded from the run, or remeasured manually via movable grid lines, at which point statistics are updated on the fly.

"With the automated microhardness testing system, we are able to go beyond the standard norm and extract data previously not attainable using manual methods," says Matt Carter, an Associate Technical Fellow at Boeing. "More data has permitted us to better understand our processes, and has resulted in a higher quality product." ■

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