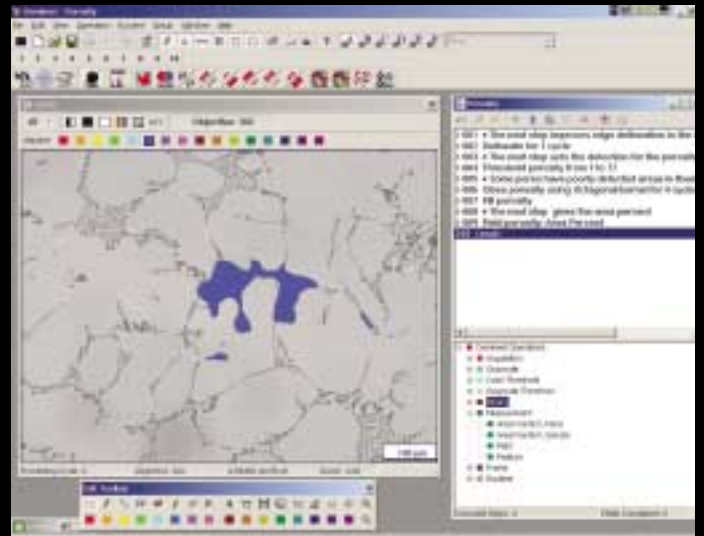
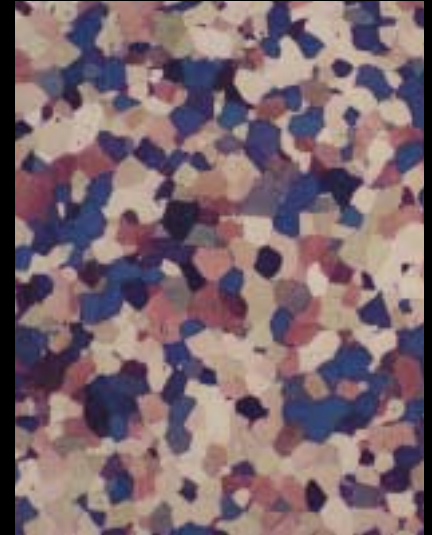


# BUEHLER<sup>®</sup>

## OmniMet<sup>®</sup> Imaging Systems: Exploring Applications

- *A variety of OmniMet Imaging Systems to choose from according to application needs, from simple image capture, to fully flexible image analysis*
- *Choice of automation levels for measurement and results*
- *Automated data export option to Microsoft<sup>®</sup> Excel for manual point and click measures of image features including hardness indentations*
- *Image analysis application solutions to national standards including: phase area percent, grain size, coating/plating thickness, particle size analysis, decarburization determination, nodularity assessment in cast irons, and dendritic arm spacing.*



**BUEHLER**

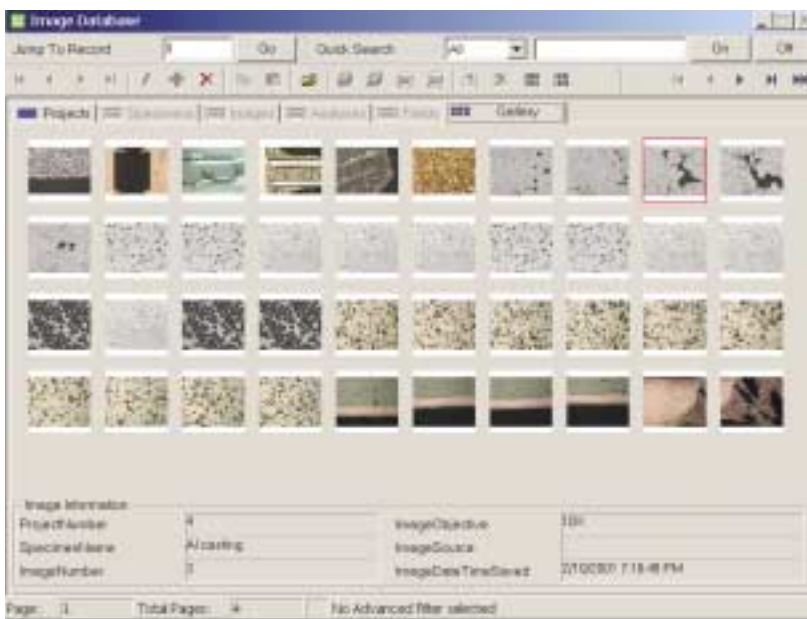
  
**EMERSON**  
Industrial Automation

# OmniMet® Imaging Systems


Imaging systems have become an integral part of materials testing labs. Images are used to evaluate research, verify quality and serve as evidence in a failure analysis. Digital images offer several advantages over traditional prints in terms of immediacy, enabling the operator to quickly detect and correct any image errors, as well as providing an overall cost reduction. The initial cost of film is eliminated and the images can be distributed electronically to as many customers as needed. In addition, associated data, captured with manual or automated image measurements, can be stored with the images in a database allowing for easy retrieval of information through later searches.

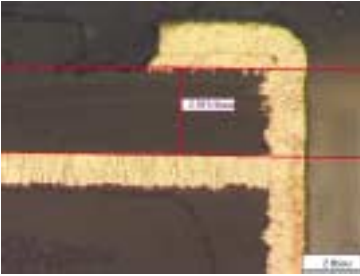
Buehler offers a series of upgradeable OmniMet® imaging products that provide:

- Image capture from digital and analog video cameras, color and mono-chrome
- Specialized image capture tool using multi-layer focusing for improved depth of field
- Image comparison of a stored standard image and the current live image
- Point-to-point, angle, hardness and other operator interactive measurements
- Traceable calibration and the option to add a scale marker overlay
- Database capable of organizing projects with associated images and data
- Viewing and reporting software for local area network (LAN) deployment in a multiple user environment
- Automated quantitative measurements through “push-button” application modules
- Operations Builder with a comprehensive toolkit of commands for customized application solution development
- Report generation capabilities with user customizable templates

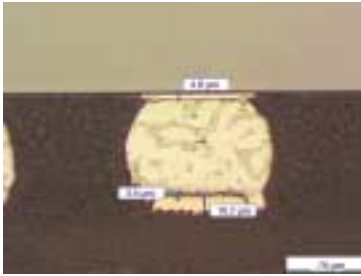


Multi-tabbed project database displaying the gallery of thumbnail images.

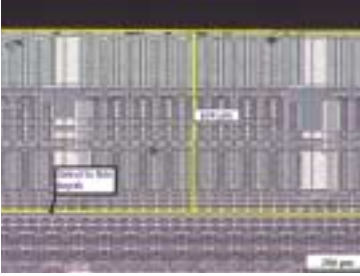

OmniMet® Report




|                   |                                 |
|-------------------|---------------------------------|
| <b>Image ID:</b>  | PCB                             |
| <b>Objective:</b> | 20X                             |
| <b>Comments:</b>  | Cross section next to thru-hole |



|                   |                   |
|-------------------|-------------------|
| <b>Image ID:</b>  | Solder Connection |
| <b>Objective:</b> | 20X               |
| <b>Comments:</b>  |                   |



|                   |                            |
|-------------------|----------------------------|
| <b>Image ID:</b>  | Silicon chip               |
| <b>Objective:</b> | 5X                         |
| <b>Comments:</b>  | First stage of preparation |



|                   |                        |
|-------------------|------------------------|
| <b>Image ID:</b>  | Circuitry              |
| <b>Objective:</b> | 100X                   |
| <b>Comments:</b>  | Cross-section revealed |

Example image report showing: scale bars, manual interactive measurements, annotations and bookmarked text entry from the OmniMet database.

# Key Features of OmniMet® Imaging Systems

## Image Measurement and Annotation

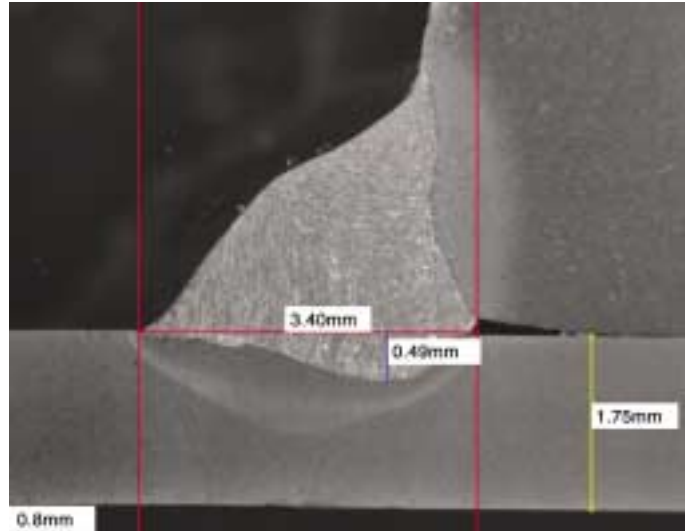
- Use the mouse to select the start and end points of each feature to accomplish manual interactive measurements. The toolbar provides linear measurements (point-to-point), curvilinear, parallel, angle, and radius as well as allowing the addition of annotations.
- A calibrated scale bar is easily attached to the image for archiving, display or image printing

## Database

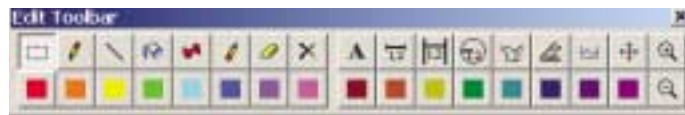
- The OmniMet® database is engineered to accommodate images as well as standard information collected during the metallographic and analysis processes
- Multi-tabbed folders enable logical storage of information with user definable field headings
- Easy-to-use filters quickly locate and retrieve required images
- Images and data are easily archived or backed up to other logical drives or removable media and later de-archived or restored as needed

## Reporting

- The built-in Report Generator allows the user to select a single image or a series of images for automated report creation
- Select an appropriate template from those supplied, or create a customized template
- Following automated analysis, reports with images and data are easily created



Operator interactive measurements of the weld leg (red), penetration (blue) and plate thickness (yellow) using the parallel and point-to-point tools for a low-carbon steel lap weld.

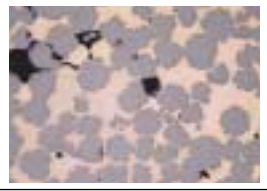
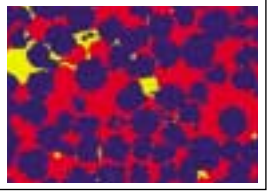


Edit toolbar for manual interactive image modification and semi-automated measurements

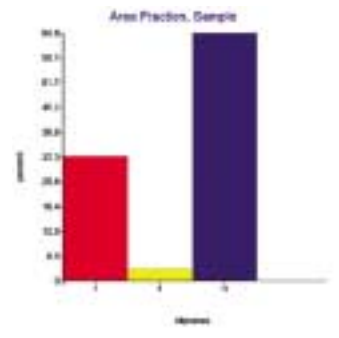
*Your logo and company name here*

**Requester:** QC Mgr  
**Vendor:** PM Inc.  
**Material:** Low density Cu infiltrated  
**Heat No:** Cu42

**OmniMet® Report**  
**Report:** 110903  
**Objective:** 20x  
**Calibration:** 0.4208µm/pixel

**Figure 3. Image Analysis Measurements**



**Field Summary**

|          |     |
|----------|-----|
| Original |     |
| Color    | 25% |
| Phase    | 25% |
| Area     | 25% |

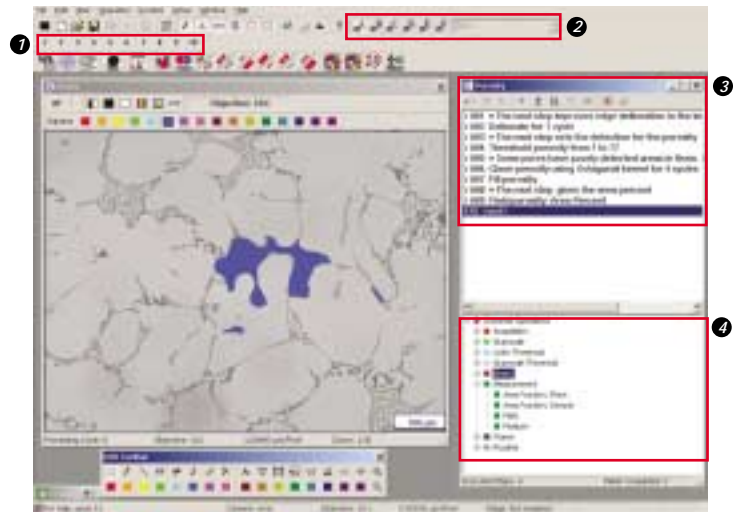
**Area Fraction**

|       |     |
|-------|-----|
| Color | 25% |
| Phase | 25% |
| Area  | 25% |

Comments: \_\_\_\_\_

Signature: \_\_\_\_\_

Image Analysis report for a multiple phase material with embedded results and images.



User interface with: 1) Push buttons for routine shortcuts, 2) Multiple image sources and magnification selection, 3) Current application routine (analysis of porosity in cast aluminum), 4) Operations builder for modifying the current routine or for building a new one.



## Phase Percentage

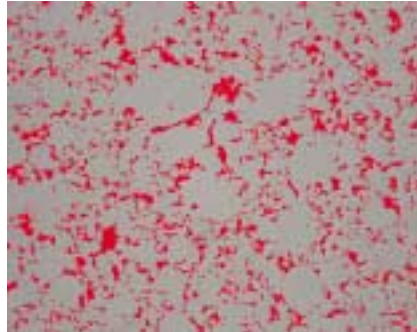
Quantitative image analysis makes it possible to detect one or multiple phases in a single image, the phases are measured and graphed. For a more complete analysis, the routine is typically run over multiple fields to determine an average area percentage.

### Steel – Powder Metallurgy

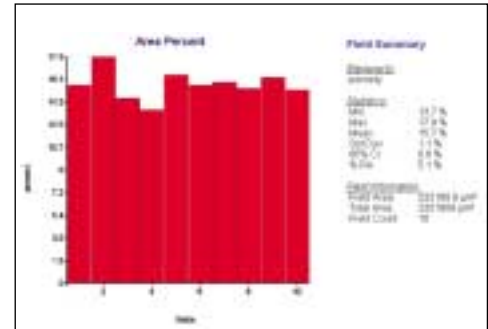
Components are created with powder metallurgy techniques to have a controlled amount of porosity. The level of porosity will determine its suitability for a given application. The OmniMet® Image Analysis Systems can identify the percentage of porosity as well as measure key characteristics for individual pores such as size, location and shape.



As polished ferrous gear formed by powder metallurgy processes.



The porosity has been detected with the red bit-plane.



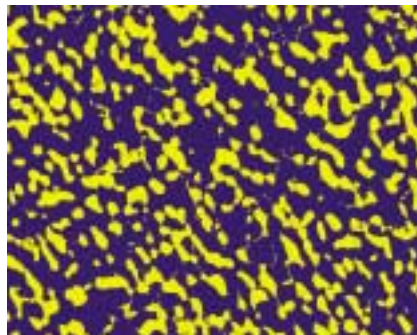
The area percent porosity distribution shown for ten fields.

### Ti Alloy – Wrought

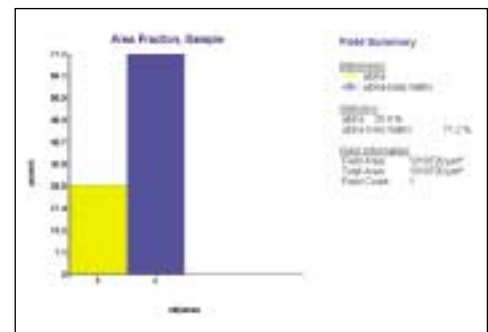
Titanium alloys are widely used due to their superior strength to weight ratios, bio-compatibility and durability. The microstructures of Ti alloys, such as this near alpha alloy, are highly dependent on the heat treatment process.



Microstructure of wrought Ti-8%Al – 1%Mo-1%V etched with Kroll's reagent.



Primary alpha grains (yellow) and a fine alpha-beta matrix structure (dark blue) have been detected.



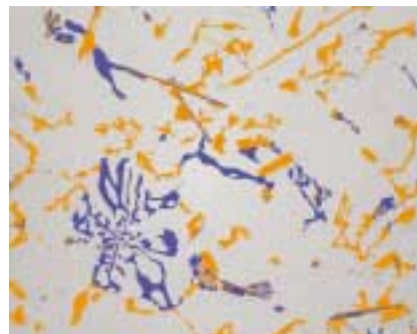
The graph displays the area percentage of primary alpha and the alpha-beta matrix.

### Al Alloy – Casting

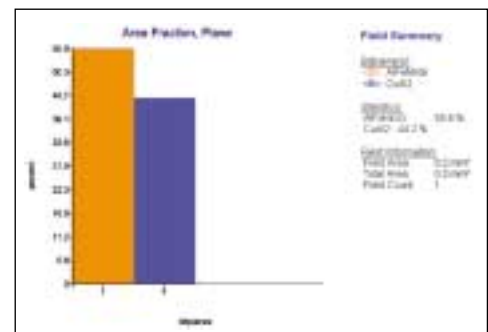
In automotive and other industries, aluminum alloys are the main material of choice to meet demanding weight and manufacturability requirements. The percentages of eutectic silicon and intermetallic phases present have a strong influence on the machinability of the alloy.



As polished type 332 cast Al with phosphorous.



The intermetallic phases have been detected with orange and blue bitplanes.



Relative area fraction of intermetallics; orange – AlFeMnSi and blue – CuAl<sub>2</sub>.

# Grain Size

Image analysis systems provide a rapid and accurate means for automating the equivalent grain size determinations traditionally conducted manually according to ASTM E 112, E 1181, E 930 and ISO 643. When etching is unable to produce complete grain boundaries, or if there is twinning present, binary modifications may be employed to provide corrections. If a specification cites grain size limitations, the outlier grains may be transferred to a different bitplane color to provide visual as well as numeric indications.

*Select the method that best meets your needs.*

## Field Grain Size

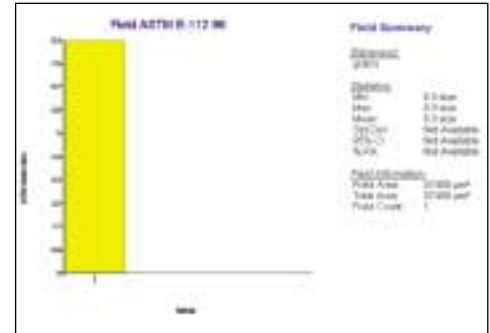
For determining the average ASTM grain size number in the field of measure, all of the rows and columns of pixels are used as intersection lines to calculate the grain size for each field of view.



Low carbon steel alloy etched with picral to reveal the grain boundaries.



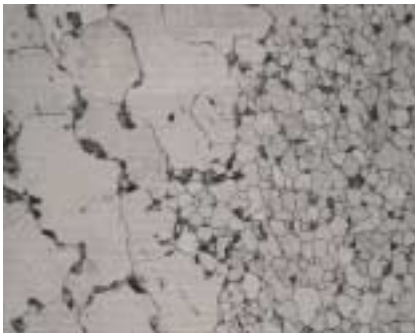
After detecting the grains, the boundaries are thinned to be only one pixel wide.



The graph displays the average grain size for a single field.

## Feature Grain Size

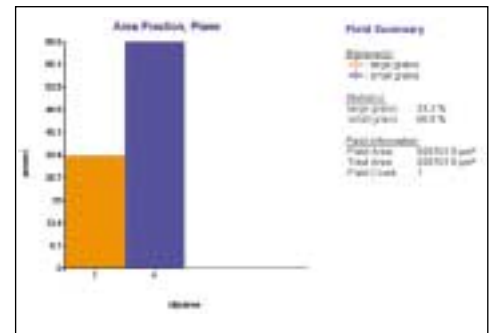
In some cases, an average grain size doesn't represent the structure accurately. The size of each individual grain can be determined based on area. The grains can then be sorted into categories and the relative area fraction occupied by each grain size can be calculated. This is particularly helpful when examining duplex structures or estimating the largest grain observed (ALA grain size).



Carbon steel alloy etched with 2% nital to display the grain size variation as a result of the forming process.



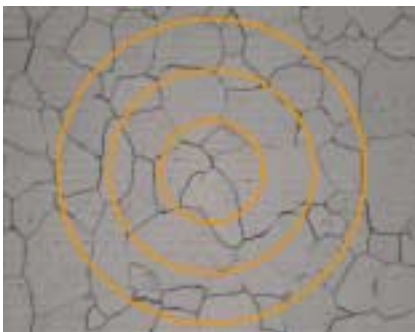
The grains were sorted into two categories based on a histogram of the size distribution.



The graph displays the relative area fraction of each grain size in the duplex structure.

## Traditional Methods

It is also possible to replicate traditional methods, such as determining the grain size based on the number of intercepts per line length on an overlaid grid.



An illustration of the Abrams Three-Circle Procedure adapted for automated image analysis use.



An illustration of the Heyn Lineal Intercept Procedure adapted for automated image analysis use.



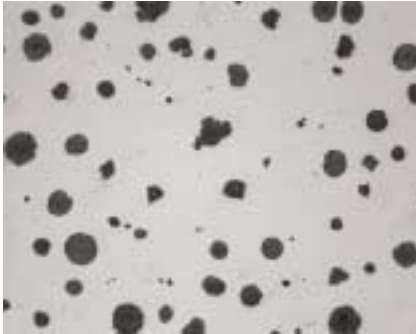
The total line length of the three circles is compared to the number of intercepts and averaged for ten random fields.

## Feature Shape and Size

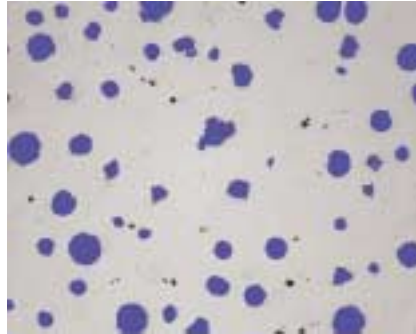
Individual features within the image can be measured providing the total number present, number per unit area, maximum size, average size and the size distribution in the form of a histogram. In addition, there are several approaches to classifying the shape of features by comparing the perimeter and area.

### Ductile Iron

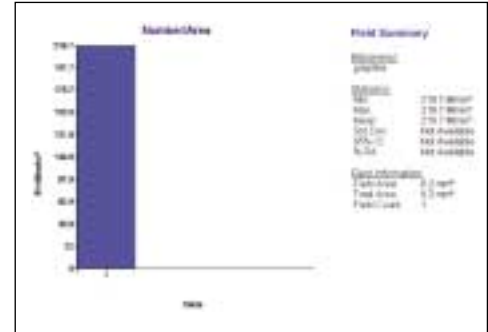
Ductile iron was developed such that the graphite will occur in the form of spherical nodules with the result of dramatically improved mechanical properties. However, variations in chemistry and other processing factors can cause the nodules to be irregular, leading to some degradation of the properties. The ability to monitor the graphite shape or determine “nodularity” is another capability of image analysis.



As polished, ductile iron specimen.



Graphite particles larger than 10µm diameter have been highlighted with the blue bitplane.



The number of particles per square mm is displayed.

### Gray Iron

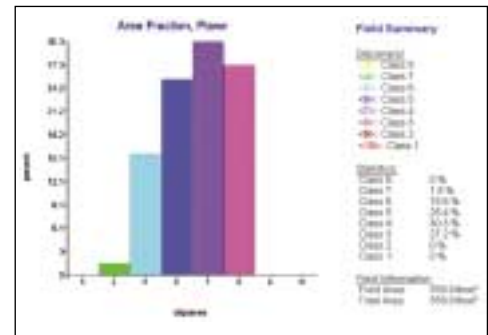
Graphite flake analysis is often of key interest to suppliers and purchasers of gray iron. The graphite size distribution as measured by its string length is linked to mechanical properties such as tensile strength and ductility. In addition to providing a distribution histogram, it is possible to sort the graphite into classes such as those indicated in ASTM A247.



As polished, gray iron specimen.



Individual flakes have been color coded based on string length.



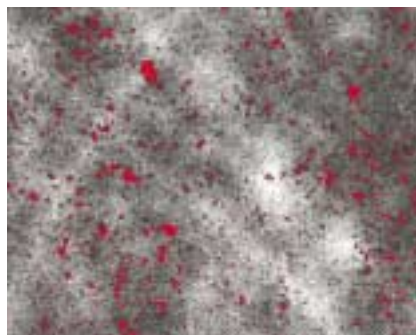
Relative area fraction of the eight ASTM A247 graphite size classes.

### Hydraulic Fluids

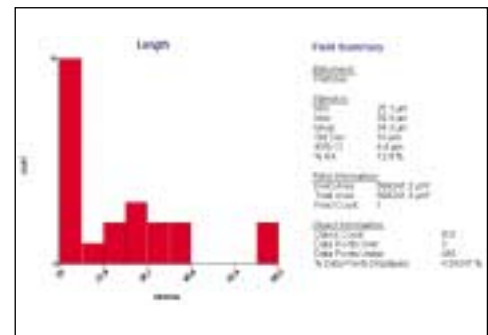
Cleanliness is key in manufacturing and maintaining precision components such as fuel injectors and hydraulic fittings. Metal filings or dirt residue could block the opening of the injector and prevent it from functioning correctly. Measuring the size distribution and total count of particles within a defined area will allow determination of compliance to cleanliness standards such as ISO 4406/4407.



Debris from transmission fluid captured with filter paper.



Debris particles have been detected with the red bitplane.



The graph parameters have been set to display only particles with a length greater than or equal to 25µm.

# Linear Measurements

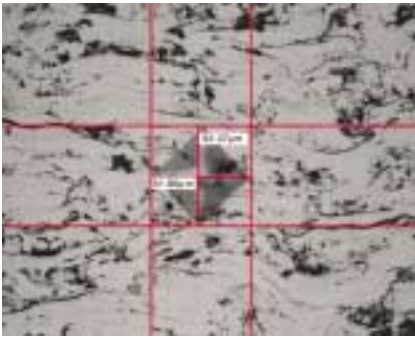
Simple point-to-point measurements are widely used for making occasional measurements; however, in cases where a high quantity of measurements and more statistics are required, automated image analysis techniques are often used.

## Hardness

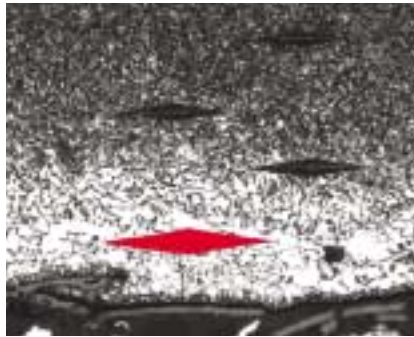
**Manual Interactive** – All of the measurement tools on the toolbar are available for interactive measurements. Each measurement will be visible on the image and the data is automatically transferred to a Microsoft® Excel report.

**Automated** – Indents can be readily detected based on grayscale differences for most materials. Automated measurement of the indent diagonal(s) are then generated and exported to Microsoft® Excel.

Using either method, specific report templates have been created for Vickers, Knoop and Brinell. Report format choices include: statistical output, profile (graph) and effective case depth determination.



Manual Interactive measurement of a Vickers indentation in a thermally sprayed coating accomplished with the parallel line tool.



Automated detection of a Knoop indentation in a decarburized zone.

| Indentation | Diagonal | Case Depth |
|-------------|----------|------------|
| 1.0         | 0.15     | 0.005      |
| 1.1         | 0.16     | 0.005      |
| 1.2         | 0.17     | 0.005      |
| 1.3         | 0.18     | 0.005      |
| 1.4         | 0.19     | 0.005      |
| 1.5         | 0.20     | 0.005      |
| 1.6         | 0.21     | 0.005      |
| 1.7         | 0.22     | 0.005      |
| 1.8         | 0.23     | 0.005      |
| 1.9         | 0.24     | 0.005      |
| 2.0         | 0.25     | 0.005      |

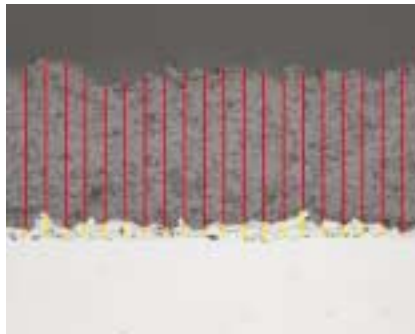
A template for Vickers readings complete with effective case depth determinations at two limits.

## Thermally Sprayed Coatings

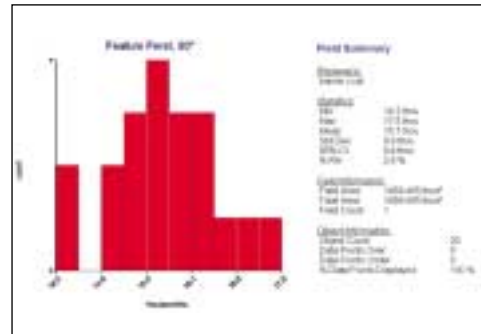
Thermally sprayed coatings provide a protective surface layer for components that may be exposed to excessive wear or extreme temperatures. Image analysis is often employed to measure the layer thickness and provide a complete statistical analysis of the data. Further analysis can also be conducted to evaluate porosity, retained grit blast, surface roughness and the presence of unmelted particles.



As polished 8% yttria stabilized zirconia thermally sprayed coating with a NiCrAl bond coat.



Measurement chords (red and yellow) distributed across the coatings to determine the thickness of each layer.



The graph displays a statistical analysis of the barrier coating thickness variation.

Buehler continuously makes product improvements; therefore, technical specifications are subject to change without notice. For a complete listing of Buehler equipment and consumables please refer to our Buehler Consumables and Equipment Buyers Guides.

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