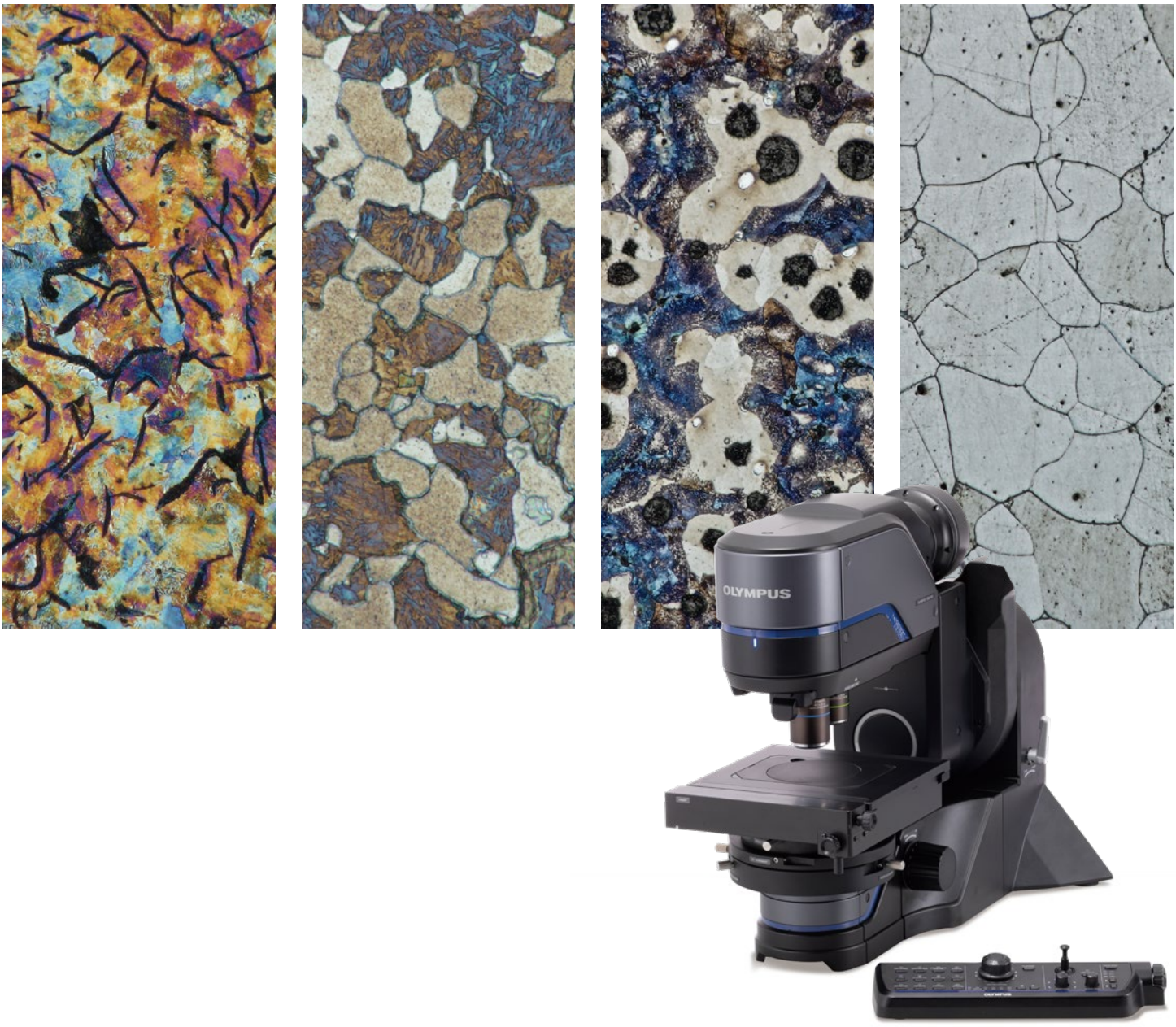
OLYMPUS

Overcoming the Challenges of Metallographic Examination Using a Digital Microscope



Improve Your Process for Higher Throughput

Inspecting metal structures using a conventional optical microscope can be challenging:

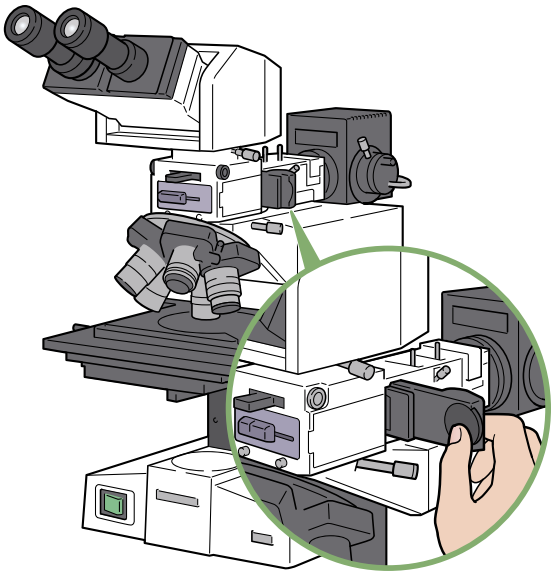
- The microscope is complicated, and it takes a lot of time and effort to get a good image
- The image quality changes depending on who's using the microscope
- Under low magnification, it's hard to see a metal structure's grain boundaries
- The metal samples need to be polished and made flat to be observed, and this takes skill and experience
- The microscope can't focus on the entire polished surface at once, making it time consuming to create an image with a wide field of view
- If the sample's surface is uneven, it's difficult to determine the exact features
- It's impossible to measure surface roughness to analyze the surface's condition
- It's difficult to manually collect and analyze individual measurement results

If you've experienced any of these challenges, you know how frustrating it can be. We designed the DSX1000 digital microscope to solve these challenges so that you can improve your overall inspection process and increase your throughput.

Keep reading to learn how the DSX1000 digital microscope overcomes each of the challenges described above.

The Microscope Is Complicated and Time Consuming to Set Up

While conventional microscopes offer the multiple observation methods necessary to image the characteristics and defects of metallurgical samples, switching between observation methods can be difficult. Complicated operations and setting adjustments, such as adjusting the diaphragm and illumination and inserting filters, take time. And then trying different observation methods until you find the best one for the application can be a tedious process.

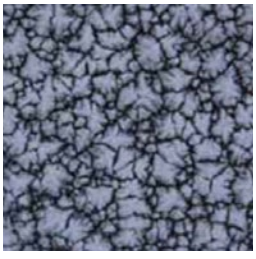


Instantly Change Observation Methods and Acquire Images with One Click

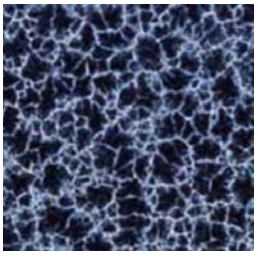
Instantly change observation methods using the software or console.

With the DSX1000 digital microscope, you can instantly switch between six observation methods by selecting them in the software or pressing a button on the console. It's simple for users of any skill level to try each method and quickly determine which one works best. The result—finding the right observation method and acquiring images is much faster.

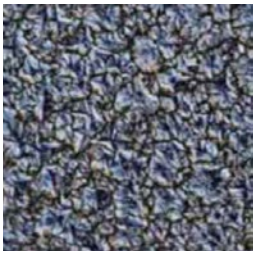
BF
Brightfield



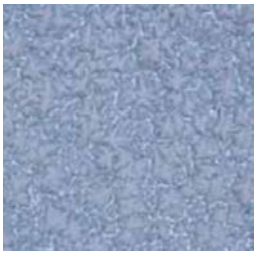
DF
Darkfield



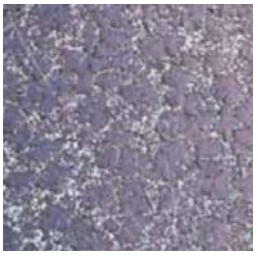
MIX
MIX (BF+DF)



DIC
Differential
Interference Contrast



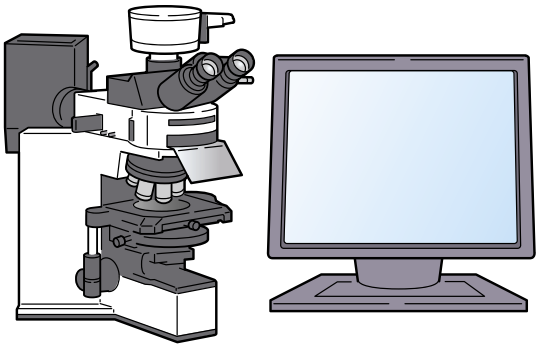
PO
Polarization



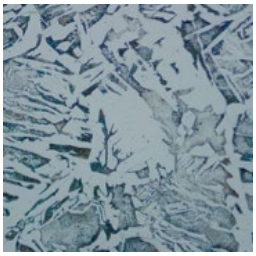
The Image Quality Is Dependent on Operator Skill

A conventional microscope has settings that require subtle adjustments, making it difficult to conduct the same observation using the same conditions every time. And since the observation conditions vary depending on the user, the observed image can change significantly.

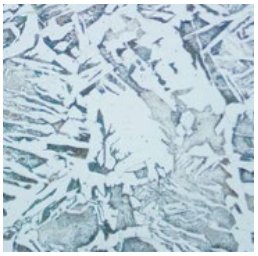
This can cause problems that impact your results.



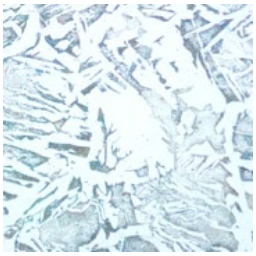
Inspector A

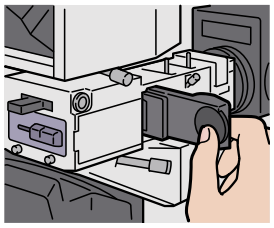


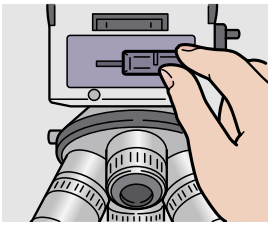
Inspector B



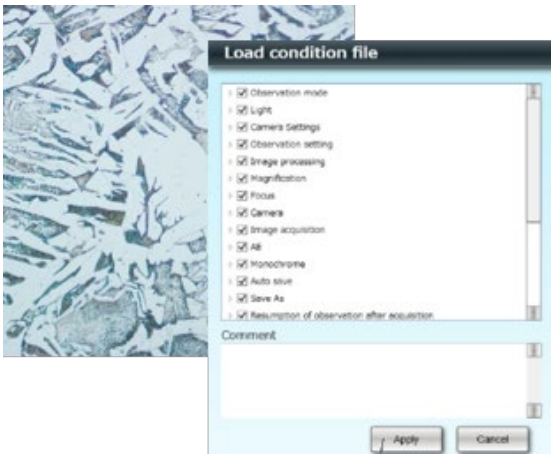
Inspector C







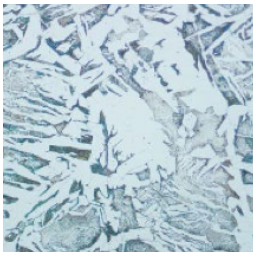
Save and Recall Settings



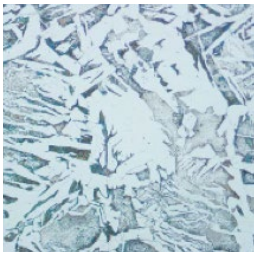
With DSX digital microscopes, the settings are simple to adjust and many adjust automatically. The microscope also keeps track of the settings for you—the acquisition conditions and microscope settings are added to captured and saved images.

If you want to use the same conditions from a previous image, you can recall the settings with one click and then make new observations. This feature is helpful for metallurgical samples since using the same conditions and settings helps make your inspections more reliable.

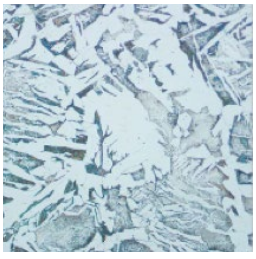
Inspector A



Inspector B

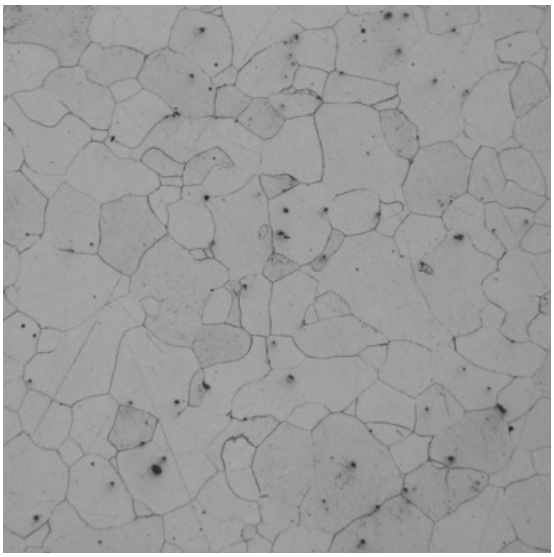


Inspector C



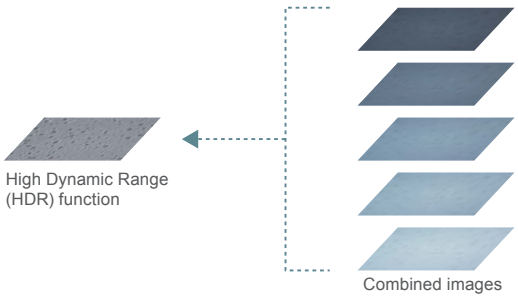
Grain Boundaries Are Difficult to Observe

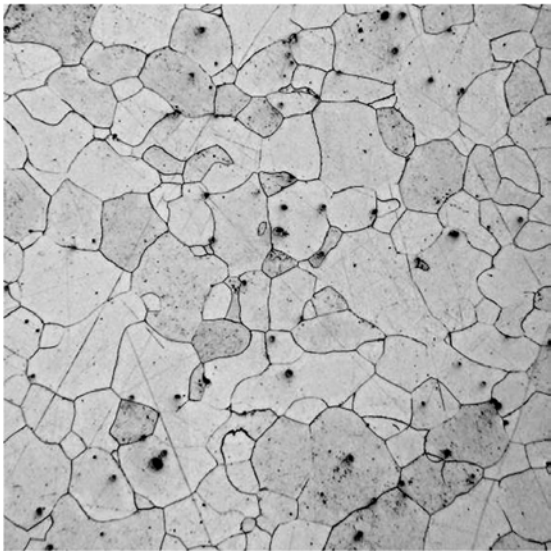
Depending on the state of the metallographic structure and etching conditions, it may not be possible to clearly capture the grain boundaries (or other microstructures) with a conventional microscope. This can complicate your pass/fail judgment of the inspection and measurements. And if you present these images to a client, they may not be persuasive.



Digital Features Enhance Grain Boundary Visibility

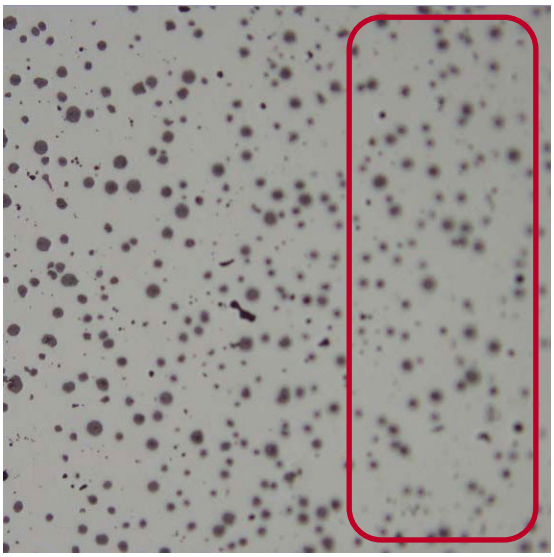
The DSX1000 digital microscope has two features—HDR and Contrast Up—that make it possible to clearly see difficult-to-view grain boundaries. Now, you can make pass/fail judgments with greater confidence and reduce your time and effort. And the images and data you present to your clients will be more compelling.





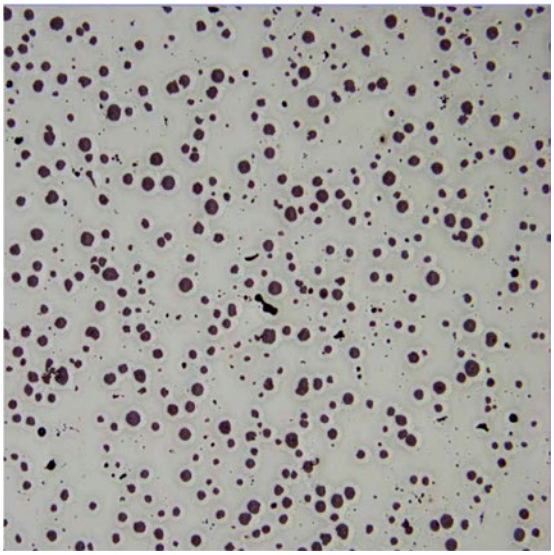
It’s Difficult to Assess the Metal Polish’s Quality

Polishing metallurgical samples takes skill and experience, and it’s critical to check the polish’s quality. It’s also important to check that the sample is very flat. If it’s not, the microscope won’t be able to focus on the entire sample. Achieving a perfectly flat sample can require a lot of trial and error in the polishing process, and this can be slow and laborious.



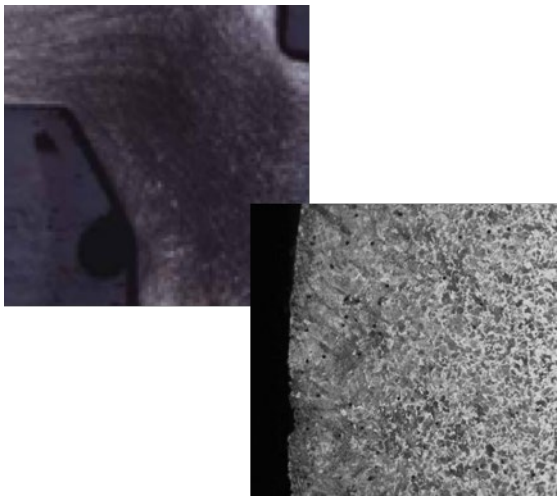
Capture Fully Focused Images of the Entire Polished Sample

The DSX digital microscope’s extended focus imaging (EFI) function makes it simple to capture fully focused images of your entire sample, even if it has irregularities and uneven areas. This means you don’t have to waste time repolishing your sample to get it perfectly flat. When you send these wide-view images to customers, they enable you to present results that are easy to understand.



The Microscope Cannot Capture Wide-Area Images

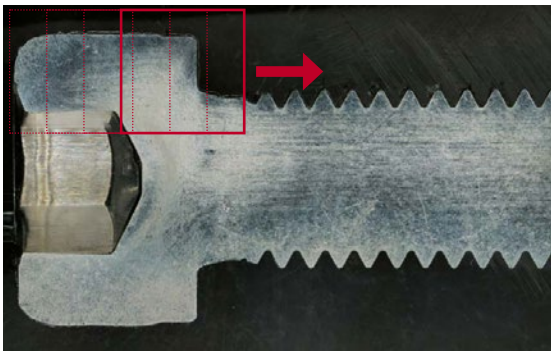
One requirement of inspecting a polished metal sample is to observe the entire sample at once to check the metal flow and the progress of any surface treatments. However, only a small region of the sample can be observed at a time using a conventional microscope. To compensate, you have to use software to stitch multiple microscope images together one by one, which can be very time consuming.



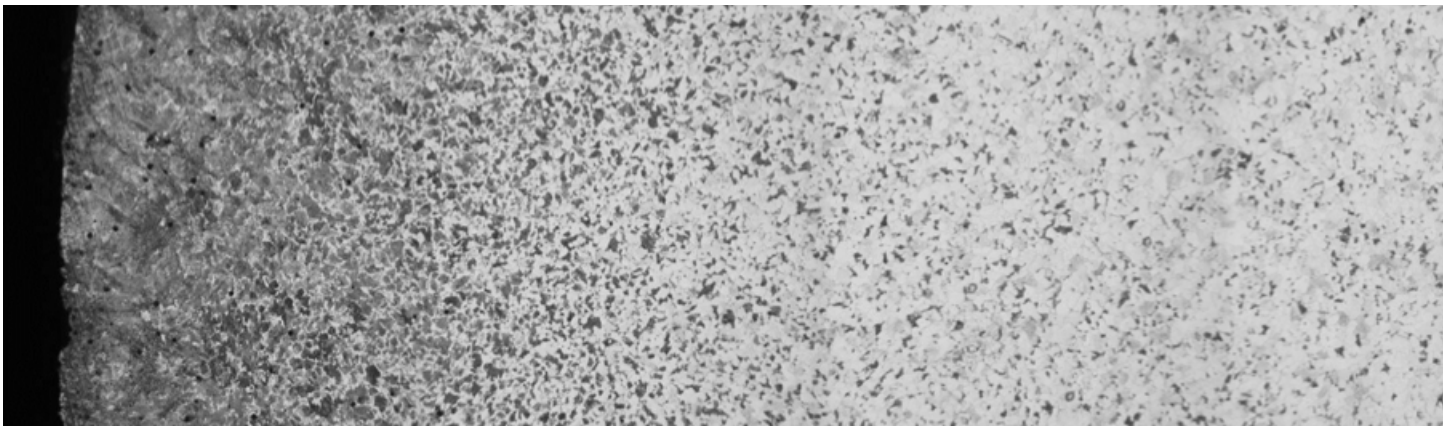
Digital Features Enhance Grain Boundary Visibility

The DSX1000 digital microscope with a motorized stage can automatically acquire images and stitch them together to create a large field of view image of your sample at high resolution.

Auto stitching makes it easy to get a complete picture of your sample with minimal time and effort. These images are also compelling to customers and facilitate collaboration during research projects.

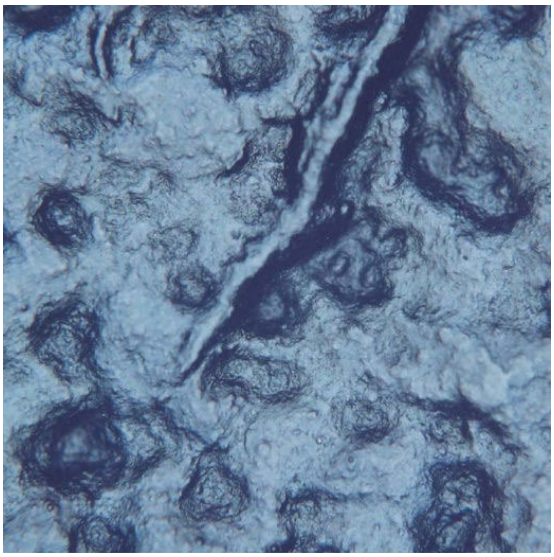


Checking the progress of carburizing



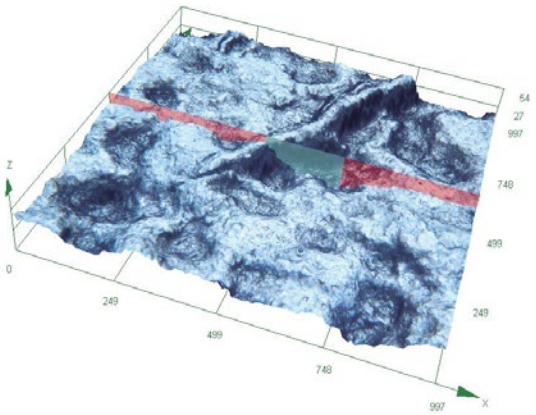
It’s Difficult to See Features on Samples with an Uneven Surface

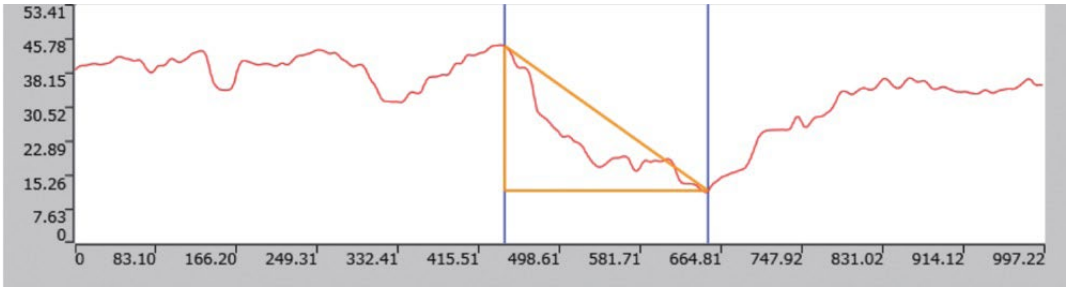
Under normal observation conditions, it’s difficult to precisely determine features or assess a sample’s unevenness using a conventional microscope. Understanding the level of unevenness in your sample is particularly important when sharing information among colleagues.



Quantitatively Assess Unevenness with 3D Images

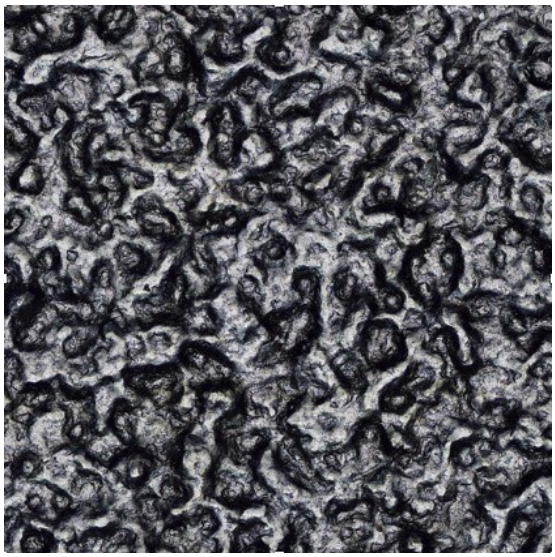
With powerful 3D imaging capabilities, the DSX1000 microscope can obtain highly accurate height information about your sample. Differences in height and volume can be measured and quantified, making it easier to understand how uneven a sample is. And the quantitative measurement makes it easy to share this information with others in an understandable way.





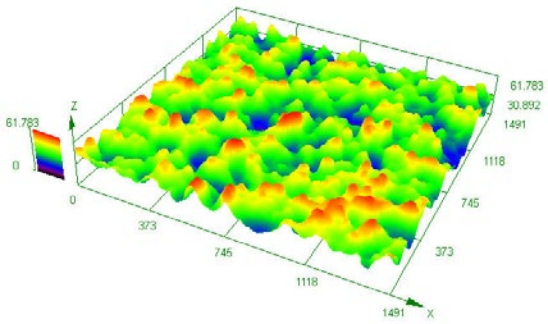
It Is Impossible to Measure Surface Roughness

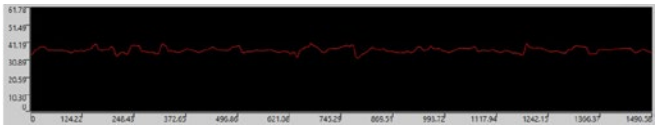
Conventional microscopes cannot be used to measure surface roughness as they don't offer the guaranteed accuracy and repeatability, or dedicated software, required for this task. However, surface roughness is important for surface conditioning analysis to determine the quality and functionality of processed surfaces and, ultimately, the performance of final products.

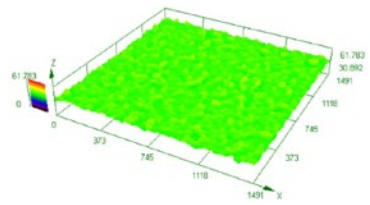


Easily Measure Linear or Areal Surface Roughness

The DSX1000 digital microscope constructs a 3D image of the sample by vertically moving the focus point to obtain accurate height information. You can easily assess the surface condition by performing linear and areal roughness measurement quantitatively using parameters like Ra, Rz, Sa, and Sz.







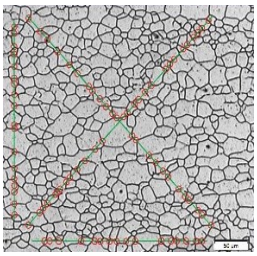
Analysis parameter			
Rp	2.285 [µm]	Rv	2.183 [µm]
Rz	4.468 [µm]	Rc	1.311 [µm]
Rt	8.705 [µm]	Ra	1.134 [µm]
Rq	1.352 [µm]	Rsk	0.145
Rku	2.297	Rsm	15.034 [µm]
RΔq	19.723 [°]	Rδc	2.348 [µm]
Rmr	100.000 [%]	Rzjis	-- [µm]

Analysis parameter			
Sq	2.098 [µm]	Ssk	0.435
Sku	3.245	Sp	9.912 [µm]
Sv	10.243 [µm]	Sz	20.155 [µm]
Sa	1.662 [µm]		

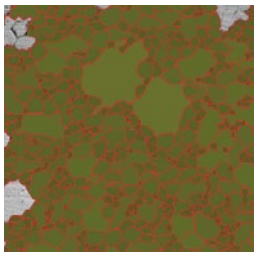
It's Difficult to Manually Collect and Analyze Individual Measurement Results

It's important that your metallurgical image analysis procedures and inspection standards meet internal and external regulations and to educate employees about how to properly follow these guidelines. However, for users with little experience, it can be difficult for them to obtain the proper results.

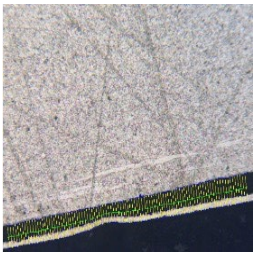
Grains analysis (intercept method)



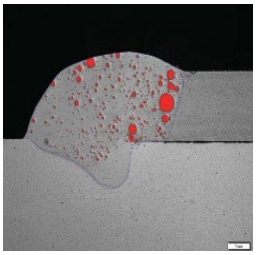
Grains analysis (planimetric method)



Layer thickness measurement

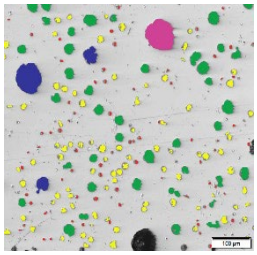


Porosity analysis



Non-metallic inclusion analysis

Cast iron analysis



Guided Workflows for Metallurgical Analysis

Using the DSX1000 digital microscope and OLYMPUS Stream™ image analysis software's Materials Solution, you can access easy step-by-step guided workflows that meet many common industrial metallurgical analysis standards, including:

- Grain sizing (ASTM E112, ISO 643, JIS G 0551/0552, DIN 50601)
- Cast iron analysis (EN ISO 945, ASTM A247, JIS G 5502)
- Non-metallic inclusion rating (ASTM E45, ISO 4967, EN 10247, JIS G 0555)
- Dendrite arm spacing measurement
- Porosity measurement (VW 50093/P6093, VDG P201/P202/P211)
- Phase analysis

Grains Intercept

Grains Planimetric

Cast Iron

Non-Metallic Inclusion

Dendrite Arm Spacing

Porosity

Phase Analysis

How the DSX1000 Digital Microscope Helps Customers

Observing a Decarbonized Structure and Texture Changes

Department

Quality Control

Sample Information

Polished metal in a resin block.

Sample Usage

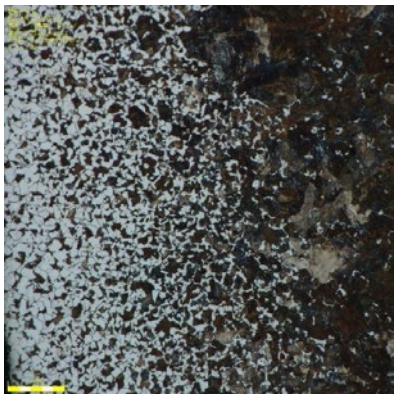
A standard test piece that is used to observe a metal structure.

Purpose of Inspection

To determine whether heat processing was performed correctly, users need to observe whether there's decarbonization on the surface of carbon steel. Decarbonization creates inhomogeneous hardening and cracking, so parts with decarbonization can have reduced mechanical performance and a shorter life span.

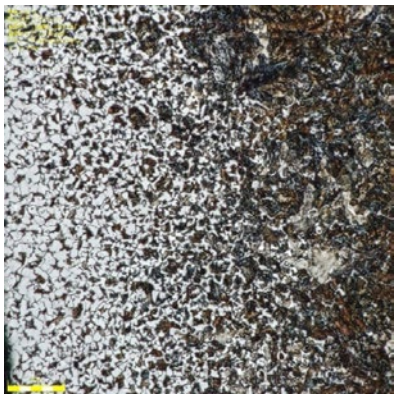
Current Inspection Method

The customer uses an inverted microscope with brightfield illumination.



Problem

The sample has a white decarbonization (ferrite) area and inner dark (perlite) area on the surface. These areas cannot be observed at the same time using a conventional microscope with a camera due to the depth of field.



Solution using the DSX1000 Digital Microscope

The microscope's high-contrast HDR function captures multiple images at different exposures so that you can clearly observe both the carbonized structure and the inner structure. In addition, the dark perlite structure can be observed using the EFI feature, which overcomes the depth of field limitations to create an all-in-focus image.

Using 3D Imaging to Observe a Fractured Metal Surface

Department

Quality Control

Sample Information

A tensile test piece made from a cobalt chrome (CoCr) alloy.

Sample Usage

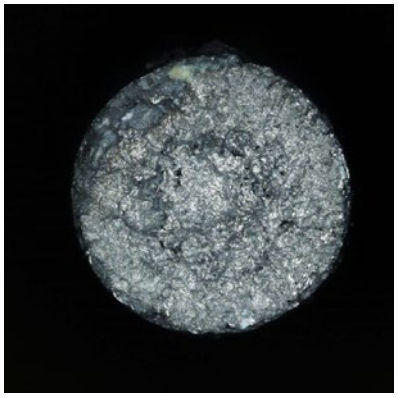
Dental alloy for artificial teeth and orthoprosthesis.

Purpose of Inspection

Assess the material's mechanical strength using a tensile test and study the state of breakdown by observing the fractured surface.

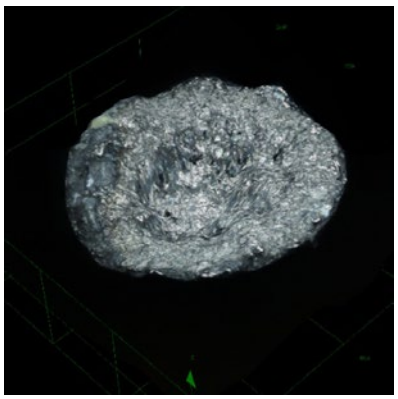
Current Inspection Method

The customer uses a stereo microscope. While they can observe the sample's unevenness by tilting it, they cannot capture a sharp image of the surface.



Problem

Due to the sample's unevenness, it's impossible to capture a clear image of the fractured surface because of the microscope's depth of focus.



Solution using the DSX1000 Digital Microscope

The microscope's EFI function makes it easy to obtain a clear image of the entire fractured surface despite the unevenness.

Using the 3D image function, you can display the fractured surface as a three-dimensional image to clearly observe the unevenness and other conditions on the sample's surface.

Checking Abrasion on an Automotive Brake Pad

Department

Research and Development

Sample Information

The sample is cut from a used brake pad.

Sample Usage

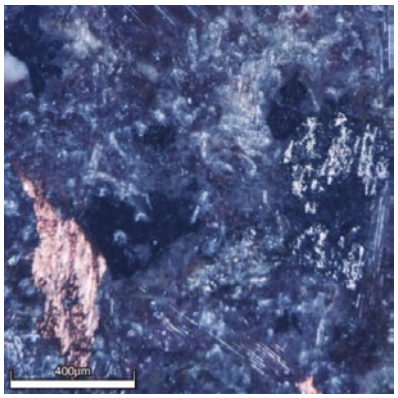
Key component used in the automotive industry.

Purpose of Inspection

In the past, brake pads were made of asbestos, which is now prohibited. The new fibers being used in the pads are tested by observing the state of abrasion to assess their effectiveness.

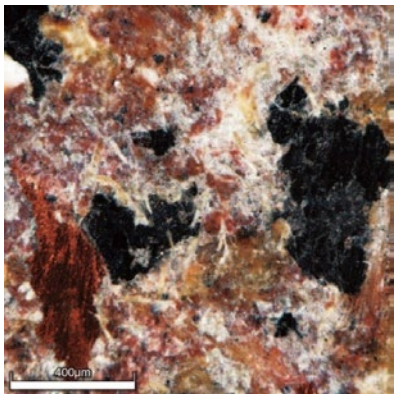
Current Inspection Method

The customer uses a standard optical microscope, but it is difficult to obtain a clear image using brightfield observation. Using polarized light helps, but it makes the overall inspection more complicated and less repeatable.



Problem

Using brightfield observation makes it difficult to obtain a sharp image because the contrast of the sample is low. Using polarized light yields better images, but it slows down the inspection.



Solution using the DSX1000 Digital Microscope

With the DSX1000 microscope's one-click observation switching, going from brightfield to polarized illumination is fast and simple. The polarized illumination images captured by the microscope are sharp and clear, making it easy to evaluate the fiber's condition.

Checking for Defects on a Cutting Tool

Department

Quality Control

Sample Information

A precision drill made of high-quality steel (top image) and an end mill made of carbon steel (bottom image).

Sample Usage

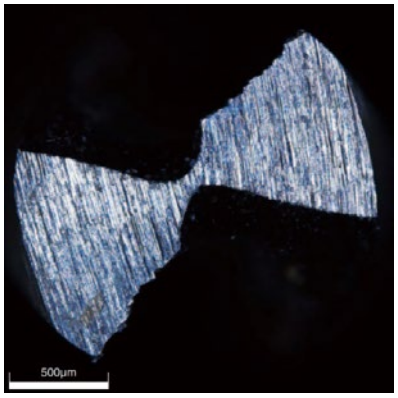
Machine tool for cutting and boring holes in metal.

Purpose of Inspection

Before a tool is shipped, it's inspected to check for any defects. If there is a defect, an image is recorded to help track down the source of the problem.

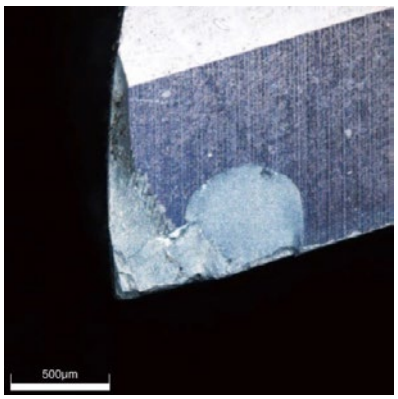
Current Inspection Method

The customer uses a stereo microscope. However, finding flaws and capturing images is challenging because the surface of the samples is so reflective.



Problem

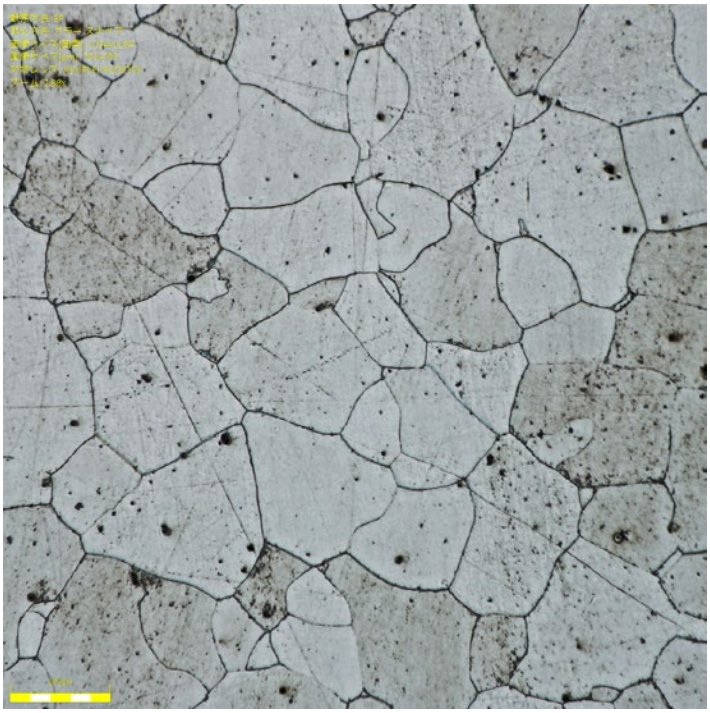
Because polished steel is so reflective, it is difficult to find flaws on steel tools' surfaces, which makes inspecting them a challenge.



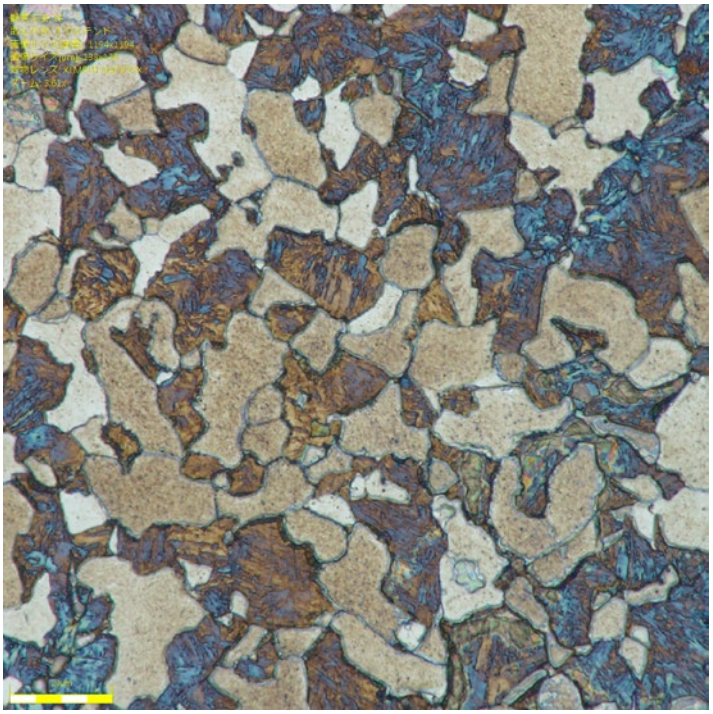
Solution using the DSX1000 Digital Microscope

Darkfield observation is effective for finding flaws on a polished surface, so the ability to rapidly change observation methods on the DSX1000 microscope is a major advantage. In addition, the microscope's EFI function makes it possible to image the sample's overall shape. For the drill shown in the upper image, EFI makes it possible to capture a focused image of the center of the drill and the area surrounding it to locate defects.

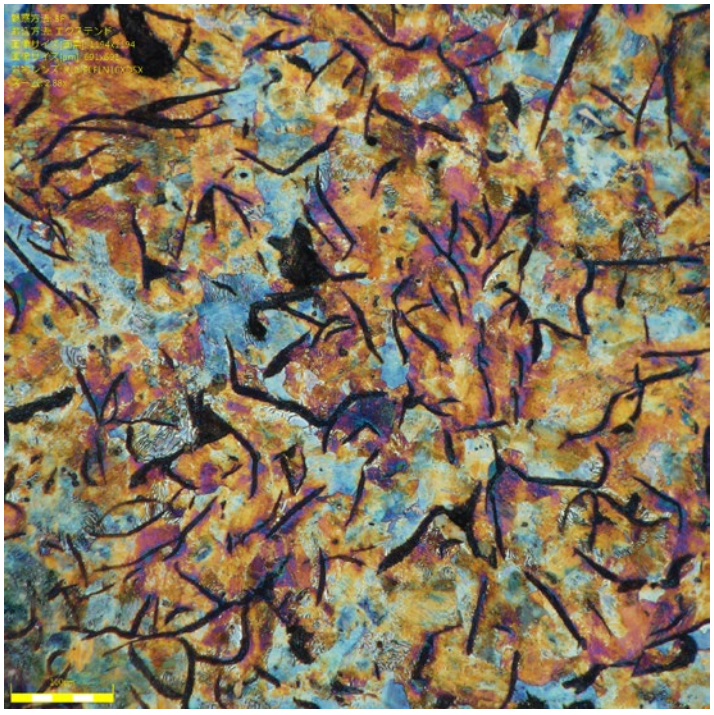
DSX1000 Sample Images



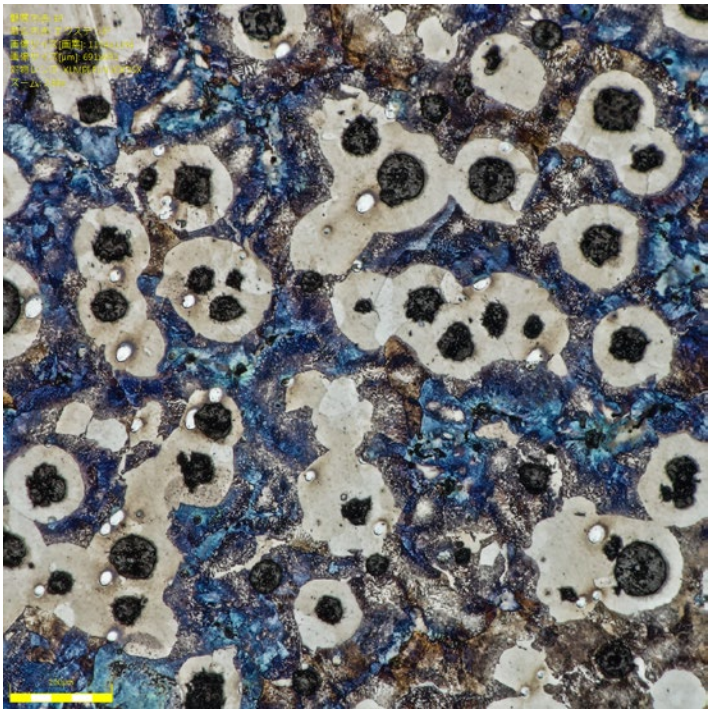
Ferrite



Martensite and Ferrite



Gray Cast Iron



Spheroidal Graphite Cast Iron

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