

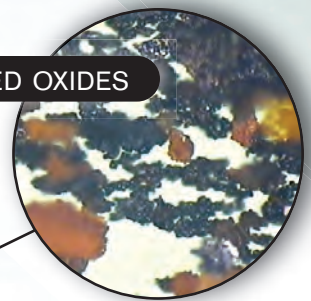


FERROGRAPHY INSTRUMENTATION

ISO 9001:2015 Certified • ISO 17025:2017 Accredited • ASTM D 7690 Approved



RED OXIDES



Red-orange particles aligned in magnetic field caused by water in the oil or poor lubricant condition.

**in accordance with ASTM D 7690*



WHAT IS FERROGRAPHY?

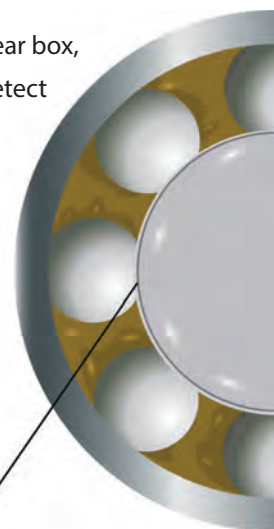
Ferrography (wear particle analysis) is a non-destructive, optical technique to evaluate the size, shape, composition and concentration of wear particles in oil or grease to determine component wear condition. This technology is one of the more sensitive non-intrusive methods to determine machine health.

The success of this technique in monitoring the condition of military aircraft engines led to further developments for other practical uses. One such development was a modification to precipitate nonmagnetic particles from lubricants and other fluids. Today, in a wide range of industries, ferrography is

helping to determine the maintenance needs for machinery by identifying the specific conditions of machine wear.

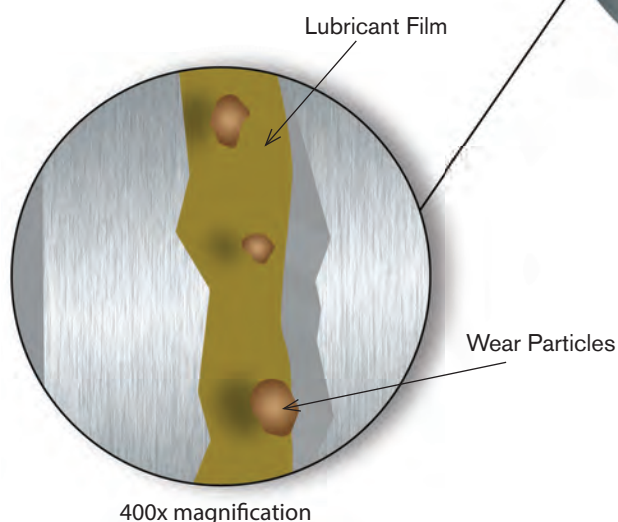
Wherever bearings, shafts, and gears turn—wherever there is moving contact between surfaces—there is wear and the generation of wear particles.

By monitoring the wear particles in engine, gear box, turbine, or transmission lubricants, you can detect the accelerated wear preceding component failure, providing you sufficient time to schedule corrective maintenance before failure occurs.



WHO CAN BENEFIT FROM FERROGRAPHY?

- Process Manufacturing
- Primary Metals
- Food & Beverage
- Municipal Utilities
- Power & Energy
- Aerospace
- Pulp & Paper
- Petrochemical
- Marine
- Mining



WHY IS IT IMPORTANT?

- Diagnose origin, characteristics, and source of wear particle debris
- Identify lubricant contamination problems before costly damages occur
- Help maintenance personnel monitor deterioration to get maximum use out of wearing components without risking secondary damage
- Predict potential failure early, so personnel can schedule timely repairs without negatively impacting production schedules
- Reduce part inventory requirements and routine preventive overhauls through early predictions of wear that accurately identify wearing components

COMPLETE WEAR PARTICLE ANALYSIS LABORATORY SYSTEM

Trico's basic system for wear particle analysis includes all the instruments, supplies, and training you need to establish an on-site Ferrographic predictive maintenance program.

Reduce the risk of catastrophic equipment failures by building your own on-site wear particle analysis lab. Trico's Ferrography instrumentation provides all the materials you need to implement an on-site wear particle analysis lab including easy-to-use instruments, supplies, accessories, and training. Our instruments are economical, reliable, and extremely precise.

The system includes:

- Direct Reading Ferrograph DR-7
- Ferrogram Maker FM-6
- Ferroscope FS-6
- Computer using the most up-to-date technology
- Large format monitor
- Imaging and imagery capture system software
- High quality laser printer
- Supplies and accessories for 200 samples
- On-site set-up and initial training



BENEFITS:

- Basic lubricant is screened, producing alerts on abnormal data, reducing time spent evaluating data, and increasing lab productivity
- Software system enhances quantitative and qualitative analysis and generates reports via paper, e-mail, or internet
- Initial and ongoing support and training is provided by Trico
- Software warranty provides periodic upgrades, as new features are added

DIRECT READING FERROGRAPH DR-7

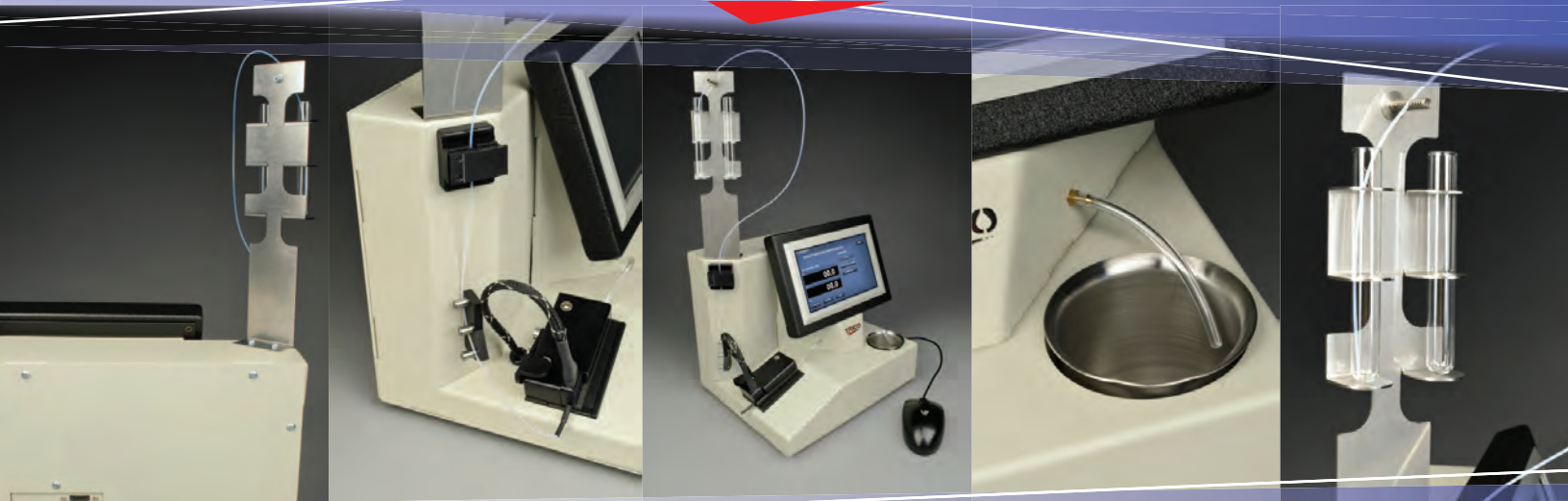
The redesigned DR-7 Ferrograph from Trico is now even more compact, portable and easy-to-operate. It quantitatively measures the concentration of wear particles in oil, while providing basic wear trend data to help determine equipment condition within minutes.

The DR-7 Ferrograph utilizes a more efficient magnetic (neodymium) gradient to trap and optically measure the amount of ferrous wear particles on a scheduled basis. The instrument also establishes the baseline wear level for any piece of equipment. Any sudden increase in the wear trend level alerts the user to potential problems prompting preventive actions.

DR-7 FERROGRAPH SPECIFICATIONS:

Length	12"
Width	10.75"
Height	21.5"
Weight	13 lbs.
Power	100-240V 50/60 Hz
Comm-Port	2 x USB 2.0
Operating System	Windows 10 IoT
Memory	64 GB Flash
Ethernet Connection	RJ45 cat 5





HOW DOES IT WORK?

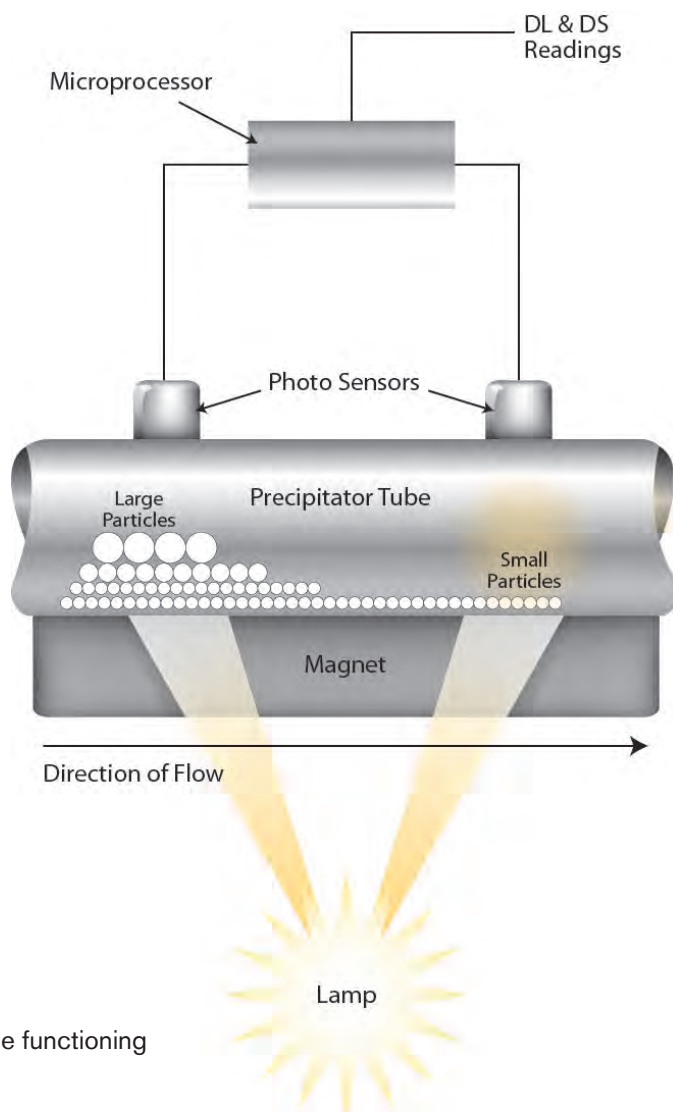
The Direct Reading Ferrograph operates by flowing lubricant through a precipitator tube over a high powered magnet. The large wear particles in the lubricant are quickly attracted to the magnet, while the smaller particles gather at the exit end of the magnet. Light is then transmitted through the sample where photo sensors on the other end measure the amount of light passing through the sample. The results received are ferrous large (DL) greater than five microns in size and ferrous small (DS) which are those particles less than five microns in size. The DL and DS results are used in specific formulas to help determine the Wear Particle Count (WPC), Percentage Large Particles (PLP), and Wear Severity Index (WSI).

BENEFITS:

- Easy-to-use touch screen interface
- New design includes a smaller footprint
- Designed with the most powerful magnet on earth, without the bulky weight
- Simple instrument set-up and operation
- Data can be obtained quickly (within a few minutes)

FEATURES:

- 7" LCD display with a more modern look and feel
- USB and Ethernet connections
- PC controlled hardware
- USB interface for external devices
- No limitations in lubricant type monitored
- Microprocessor incorporates internal diagnostics for reliable functioning
- Internal optics calibration



FERROGRAM MAKER FM-6

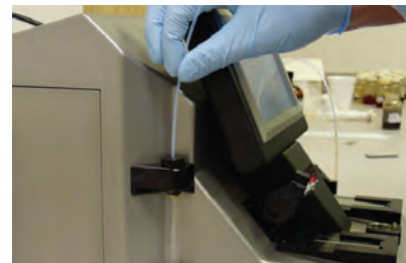
The newly redesigned Ferrogram Maker FM-6 dual slide maker is used as the first step in Analytical Ferrography. For greater productivity, the FM-6 is designed with two independent stations permitting two samples to be prepared concurrently.

Each station includes a holder which accurately positions a slide at a slight incline over a magnet, allowing particles to deposit from largest to smallest on a substrate called a Ferrogram. This deposition pattern provides good resolution of large and small particles which facilitates a diagnosis

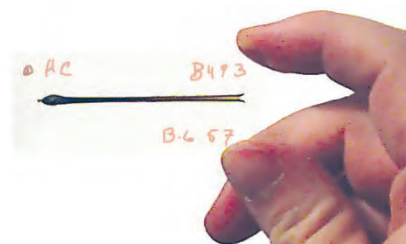
of potential wear problems. Ferrogram preparation can be done automatically, semi-automatically, or manually at the operator's option. In the automatic mode, the sample is deposited on the Ferrogram at a carefully controlled rate. At the end of the sample deposition cycle, the wash cycle is automatically initiated, and a visual signal indicates completion of the Ferrogram. The semi-automatic and manual modes provide flexibility and further operator control to perform unusual samples, such as water-based lubricants.

ANALYTICAL FERROGRAPHY SPECIFICATIONS:

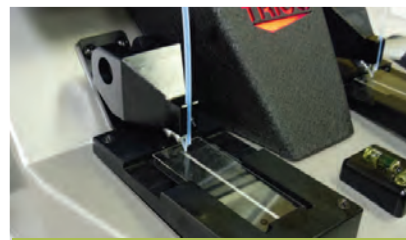
Depth	16"
Width	14"
Height	15"
Weight	27 lbs.
Power	100-240V 50/60 Hz
Comm-Port	2 x USB 2.0
Operating System	Windows 10 IoT
Memory	64 GB Flash
Ethernet Connection	RJ45 cat 5



Ferrogram Maker FM-6
Simple instrument operation



Ferrogram Slide
Particles distributed largest to smallest



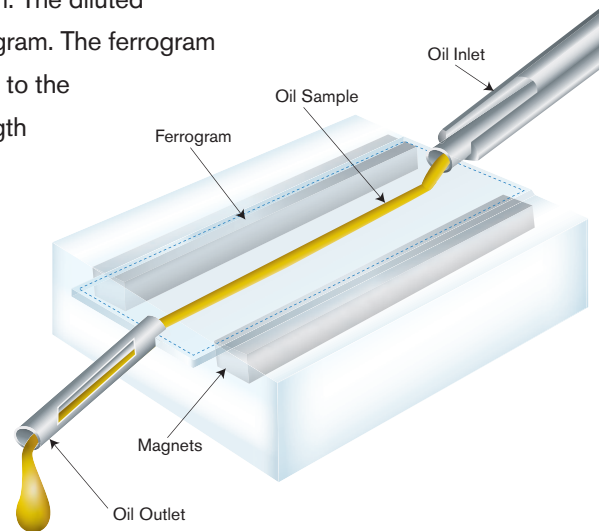
Ferrogram Maker FM-6
Simple instrument operation





HOW DOES IT WORK?

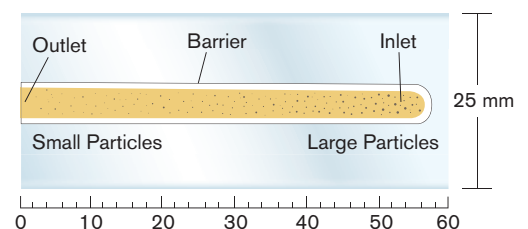
The Ferrogram Maker magnetically separates machine wear debris from the lubricating oil. The oil sample is first diluted for improved particle precipitation and adhesion. The diluted sample flows down a tube on a specially designed glass slide called a ferrogram. The ferrogram rests on a magnetic block, which attracts ferrous particles out of the oil. Due to the magnetic field, the ferrous particles align themselves in chains along the length of the slide with the largest particles being deposited at the entry point. Nonferrous particles and contaminants, unaffected by the magnetic field, travel downstream and are randomly deposited across the length of the slide. After the particles are deposited on the ferrogram, a wash is used to remove any remaining lubricant. The wash quickly evaporates and the particles are permanently attached to the slide. The ferrogram is now ready for optical examination using a Ferroscope.



FEATURES:

- Automatic operation releases labor for other tasks
- Adjustable controlled sample flow rate ensuring uniform substrate deposition and reproducibility
- Ferrograms are transparent, allowing differentiation of metallic, organic, and non-metallic particles, for easy diagnosis via the ASTM method
- Particles are sorted by magnetic susceptibility and size enabling quick interpretation
- USB and Ethernet connections
- 7" LCD display with a more modern look and feel

FERROGRAM



BENEFITS:

- Easy-to-use touch screen interface
- New design includes a smaller footprint
- Simple instrument set-up and operation
- Internal diagnostic
- Simultaneously produces two Ferrograms in less than 20 minutes
- Very little particle stacking occurs ensuring observation of important particles, critical to machine condition

FERROSCOPE FS-6

The Ferroscope FS-6 analytical ferrography optical microscope is specially assembled by Trico with attachments and options that enhance particle identification and interpretation. The Ferroscope FS-6 comes with three magnification powers -100x, 500x, 1000x. A technician can scan a Ferrogram quickly at low power looking for obvious abnormal particles, interpret particle origin and wear mechanism at 500x, and gain more insight into stress directions at 1000x.

The Ferroscope FS-6 is equipped with reflective and transmitted light sources so that a Ferrogram can be illuminated from above and below. A red light source illuminated above the Ferrogram causes the light to be reflected off particles and a green light source below the Ferrogram causes light to be transmitted. Any metallic particles will reflect light and non-metallic particles will transmit light.



FS-6 FERROSCOPE SPECIFICATIONS:

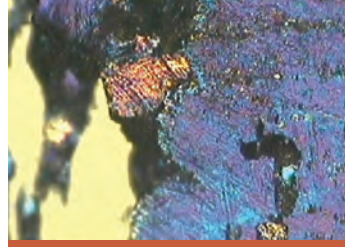
Depth	23.5"
Width	12"
Height	32"
Weight	40 lbs.
Power	100V or 220V AC

BENEFITS:

- Field of view is 50% greater than previous ferrosopes, optics are infinity corrected eliminating focus problems
- Light source powers are increased in intensity over past models allowing better definition and much better photography (photomicroscopy)
- Tri-nocular system allows the addition of cameras, including video, and digital photography (microscopy)

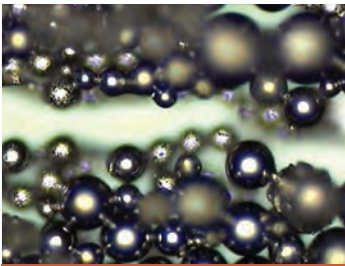


Abrasive Wear
Long curved strips of metal. Heat treated

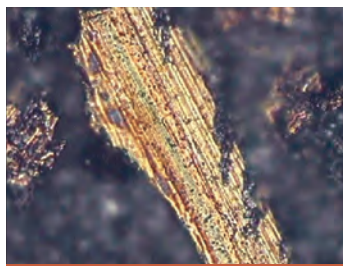


Chunks
Flat striated particles. Heat treated

* photos based on
ASTM D 7690



Spheres
Small spheres < 5 microns in diameter



Severe Wear
Flat elongated > 20 microns with striations



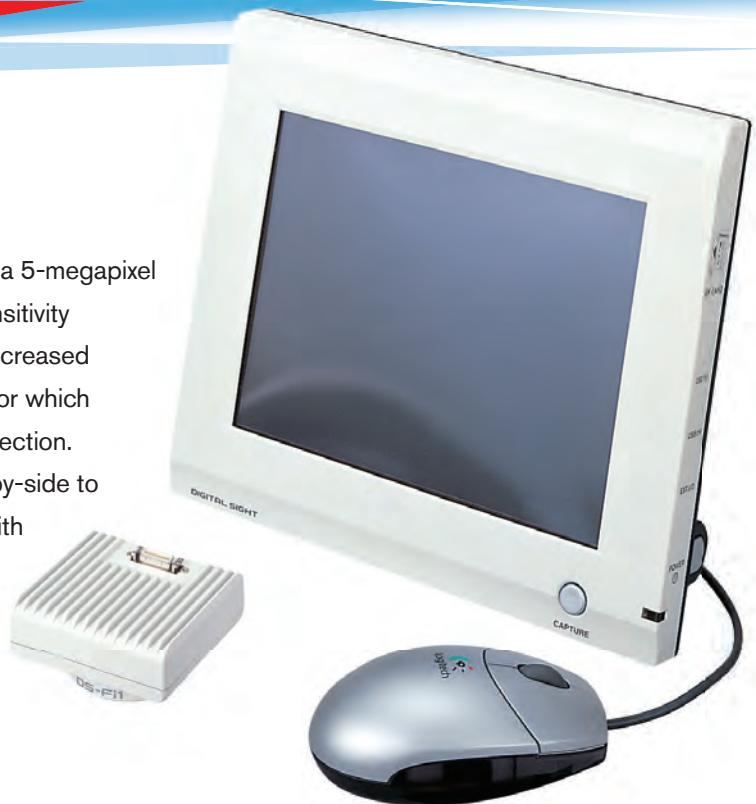
Fibers
Non-aligned and passes transmitted light

FEATURES:

- Bi-chromatic light (two light sources, reflected and transmitted) for identifying metallic versus non-metallic debris
- Three magnification powers; 100x, 500x, and 1000x enable rapid scanning to minute detailing
- Red and green light filters aid in identification of particle
- Polarizer and analyzers help identify particulate and fibrous contamination
- Ergonomic design enables analyst to rest arms on table while adjusting focus

DIGITAL CAMERA

The high-definition digital camera for the Ferroscope FS-6 features a 5-megapixel CCD that can capture wear particles. The camera improves red sensitivity by using a new IR cut filter and enhances image quality, including increased brightness through 4x binning. It features a large built-in LCD monitor which can observe samples and capture images without a computer connection. The monitor can be split in half to display still and live images side-by-side to compare and contrast a sample image that serves as a reference with a live image. The monitor has exceptional color representation with seven default gamma correction presets and another seven that can be registered by the user. It allows the user to create an original reference table.



BENEFITS:

- Data can be saved to: USB memory stick, Compact Flash card, Mass storage class, Network
- All operations can be performed by clicking on-screen menus
- A wide variety of tools unique to this camera: Crosshairs, Measurement, Scale display

FEATURES:

- Built-in LCD monitor—no computer required
- Contains two USB ports
- Scene mode enabling optimal image capture with a single click
- Supports direct printing; just connect the unit's USB port to a printer which supports the PictBridge standard

CAMERA SPECIFICATIONS:

CCD	2/3 in high density CCD (total number of pixels 5.24 mil)
Recordable Pixels	2560 x 1920 pixels, 1280 x 960 pixels, 640 x 480 pixels
Dimensions	3" W x 3" D x 1.75" H
Weight	.5 lbs.

CONTROL UNIT SPECIFICATIONS:

Digital Zoom	Up to 16x
Storage Format	BMP, JPEG (4 step compression), TIFF
Interface	USB device port x 1 (mass storage class support) USB host port x 2 (USB mouse, USB memory stick, USB keyboard, microscope connection)
Power Supply	AC100-240V 50/60 Hz
Power Consumption	70VA
Dimensions	9" W x 2.5" D x 7.875" H
Weight	3 lbs.
LCD Monitor	8.4" TFT color LCD XGA (1024 x 768) SXGA/XGA
Storage Media	Compact flash card (type 1, type II), USB memory stick, microdrive
Direct Printing	PictBridge printer (sold separately)



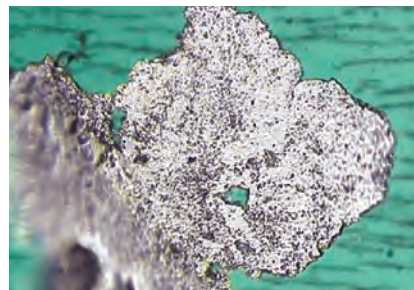
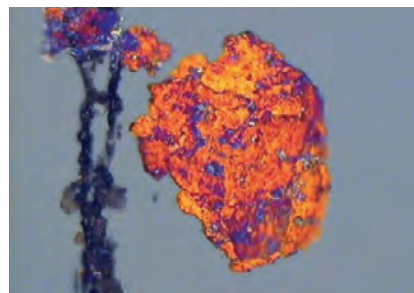
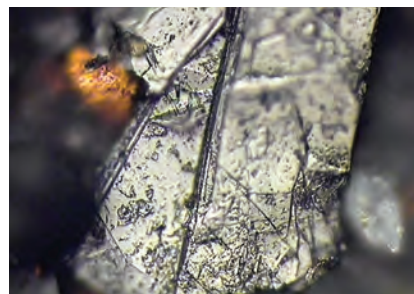
* photos based on
ASTM D 7690

IMAGERY SOFTWARE

Imagery Software will streamline image capturing, measurement and enhancement, while improving the accuracy of your Photomicrographs.

The software provides image acquisition from different software sources such as; AVI, MPG, MPEG, JPEG and movie files. Measurements are done and captured onto an MS Excel file for future analysis. The measurement scale bar can also be burned on each captured image automatically—quickly providing wear particle sizes. In addition, large wear particles difficult to bring into focus under high magnification conditions can be compensated by the software with a digital auto-correcting mode. Now you can count, size, and interpret wear particles in a matter of minutes with all of the features offered in the Imagery Software using a 32-bit/64-bit COM-based application for MS Windows which is easily expanded through plug-in components.

Combining Trico's Imagery Software with Ferrographic Instruments provides a fully capable and productive Ferrographic Laboratory with results that extend equipment health monitoring capabilities well beyond traditional methods.



BUILDING INDUSTRIAL LUBRICATION CUSTOMERS FOR LIFE

Whether you are upgrading existing Ferrography instruments or building an on-site laboratory, Trico provides all the materials you need to prevent catastrophic machinery failure. **For more information contact us at 262-691-9336 or 800-558-7008.**

