From Eye to Insight

INDUSTRIAL MANUFACTURING TECHNICAL REPORT

Automotive Industry: Rapid and Precise Surface Inspection on Hard-to-Image Samples

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Introduction

Visual inspection of automotive parts for surface flaws and defects is an essential part of product quality control and assurance (QC/QA) and failure analysis (FA).

Some of these parts are made from materials that can be difficult to analyze with optical instruments, like a microscope. The rubber of tires and plastic of car air outlet cover panels, for example, are giving low contrast with typical lighting techniques which makes the detection of flaws difficult to impossible.

The following will show how the Leica DVM6 digital microscope helps to make inspection, measurement analysis, and reporting quicker and easier.

Improve Workflow Efficiency for Hard-To Image Samples

More rapid methods for inspection and quality control (QC) of auto motive parts, such as tires and air outlet cover panels, are often advantageous for users. However, a faster inspection and QC process must still deliver reliable results.

State-of-the-art digital microscopes, like the Leica DVM6, make efficient and reliable inspection and QC possible due to:

> Reproducible microscopy by automated tracking and storing of the most important hardware parameters (encoding), e.g., the sample stage, objective and zoom optics, illumination, and camera settings allowing rapid recall of the imaging conditions;

> Fast way to change magnification with little or no interruption of workflow by swapping objective lenses and using the continuous, large-range 16:1 zoom;

> Quick and easy tilting and rotation to observe the sample from different perspectives;

> Integrated LED (light-emitting diode) ring light and coaxial illumination with versatile contrast methods;

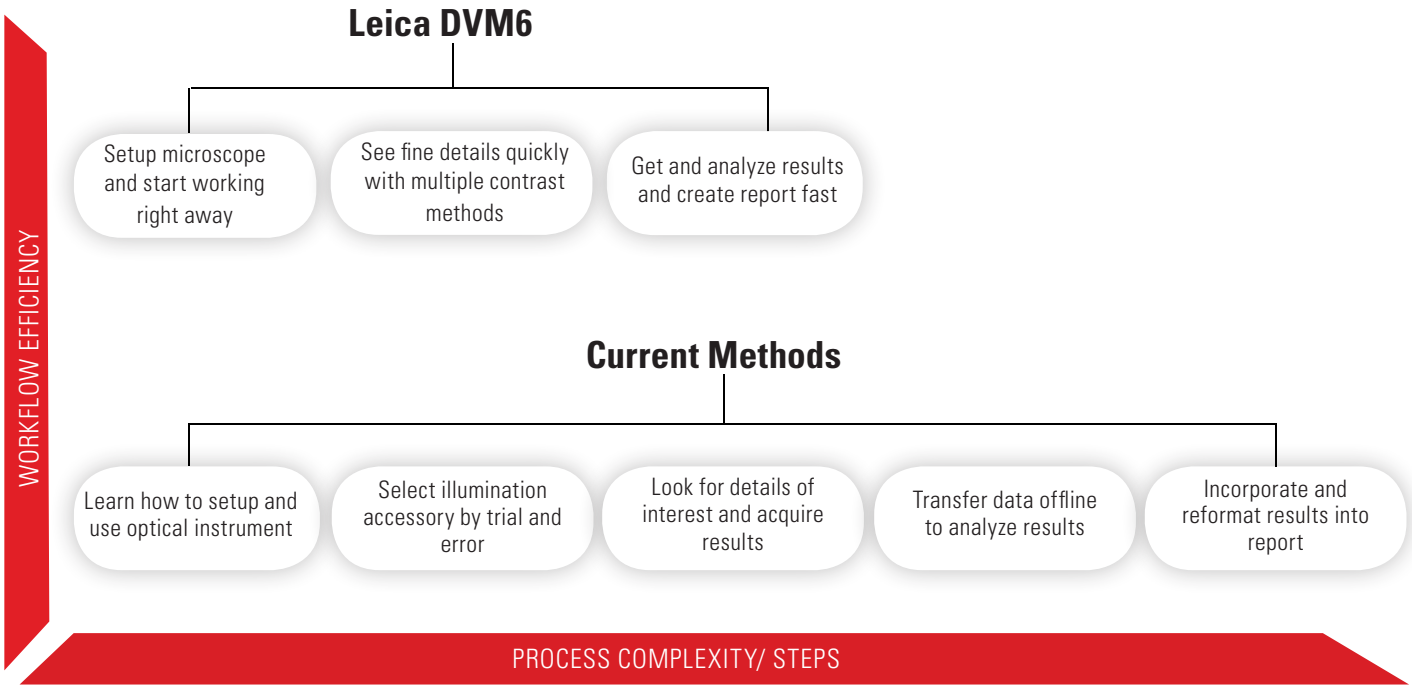
> Digital camera with fast live image and excellent digital 10MP resolution for high quality images;

> Software allowing intuitive, multi-function sample analysis and microscope operation with multiple user profiles; and

> Software enabled/supported capture modes, e.g. XY and XYZ stitching and high-dynamic-range (HDR) imaging.

The focus of this report will be on the tilting capability and versatile integrated illumination of the Leica DVM6 (points in red above) and how they make the examination of hard-to-image samples easier.

The figure below gives a flow-chart-type description explaining how the Leica DVM6 makes inspection and QC workflow more efficient compared to popular current methods. It shows increasing workflow efficiency is inversely proportional to the process complexity and the number of workflow steps.



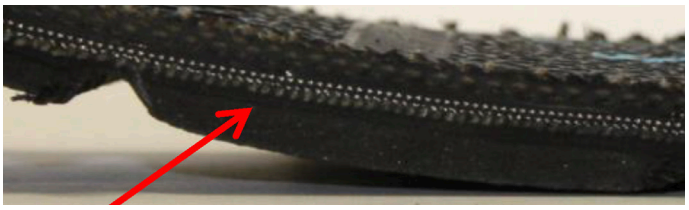
Leica DVM6 Digital Microscope: Setup and Start Working

Quick Setup and Easy

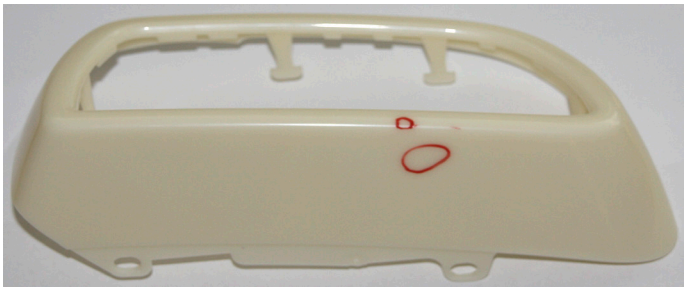
After plugging in the power cable and USB cable to the computer, put in an objective and start working with the Leica DVM6 using the Leica Application Suite X (LAS X) software. The Leica DVM6 has a maximum working distance of 60 mm and a sample stage travel range of 70 x 50 mm. The stage can handle samples up to 2 kg in weight.

Below are photos of the tread surface and cross section of the automobile tire sample, the top and side view of the air outlet cover sample, and the Leica DVM6 digital microscope with the air outlet panel placed onto its stage.

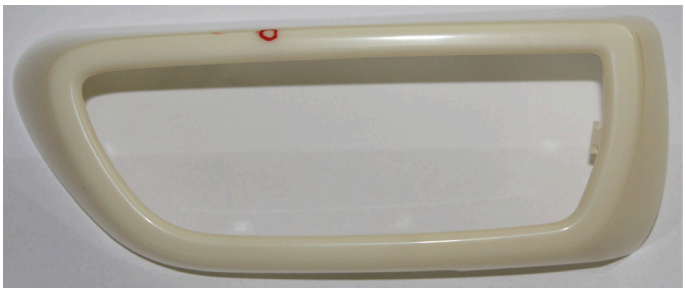
Tread surface of the automobile tire sample



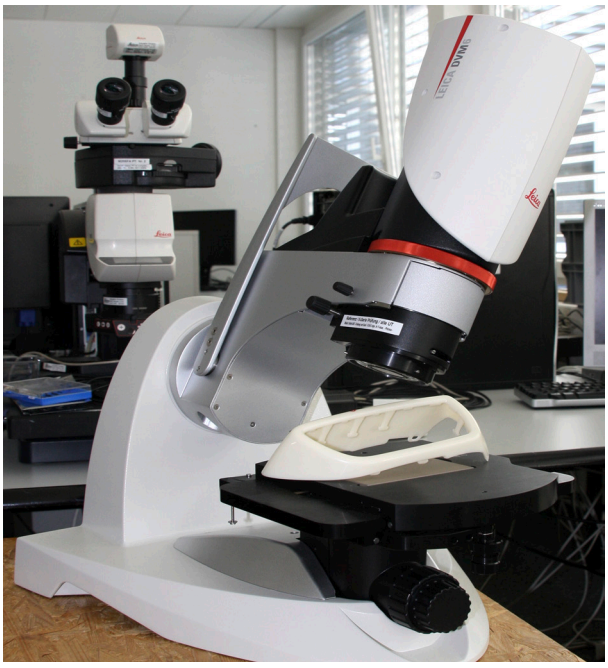
Cross section (red arrow) of the automobile tire sample with inner wall surface above



Top view of the car air outlet cover panel



Side view of the air outlet cover panel (red circles mark defects)

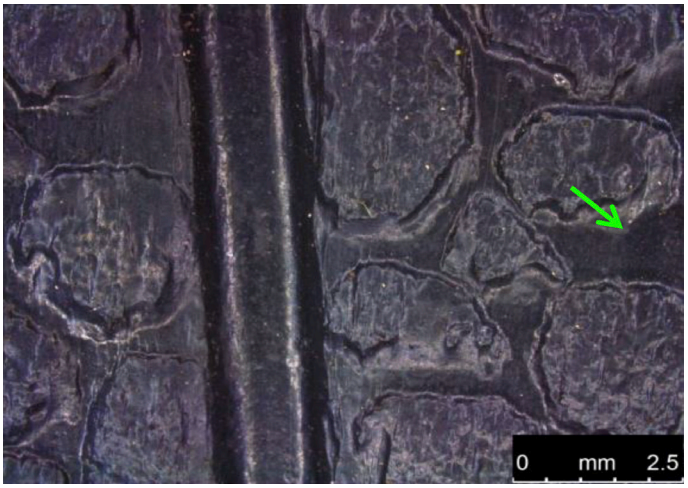


Leica DVM6 with car air outlet panel sample on stage ready for microscopic observation

See the Sample from Different Perspectives

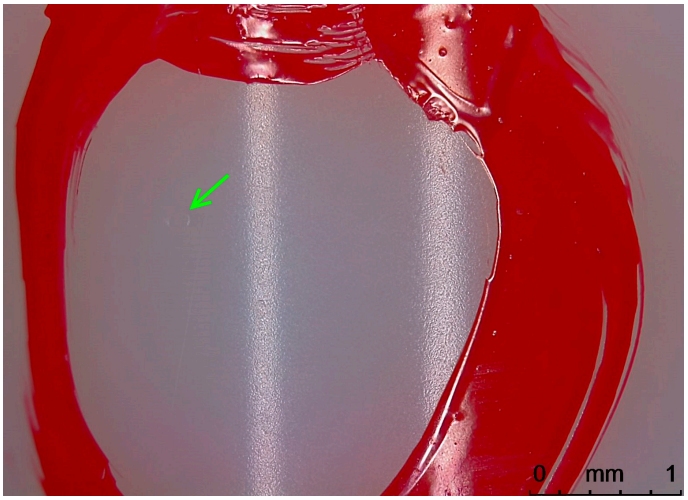
Tilting

More accurate information about the sample can be gathered when different viewing perspectives are utilized. The Leica DVM6 microscope head tilts to virtually any angle between +60° and -60° with respect to its neutral vertical position. The sample stage rotates between +180° and -180° in a continuous manner over the entire range. Some examples of the tire and air outlet panel samples studied at different tilt angles are shown below. The tilting axis is eucentric, i.e., aligned to the sample focal plane, so as long as the sample is in focus beforehand, it stays in focus when tilted to any angle. Images of the inner wall surface of an automobile tire and the outer surface of a car air outlet panel recorded with the Leica DVM6 having the following microscope head tilt angles are shown below:

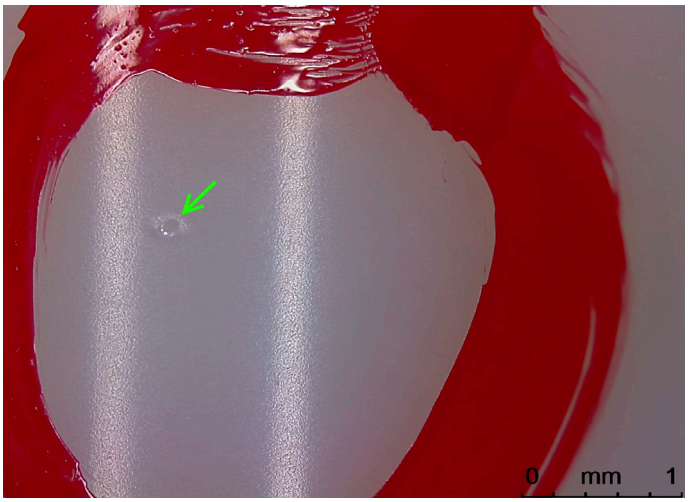


Automobile tire, tilt angle 0°

Automobile tire, tilt angle 15°: more fine details visible on the black rubber surface with tilted view



Car air outlet panel, tilt angle 0°



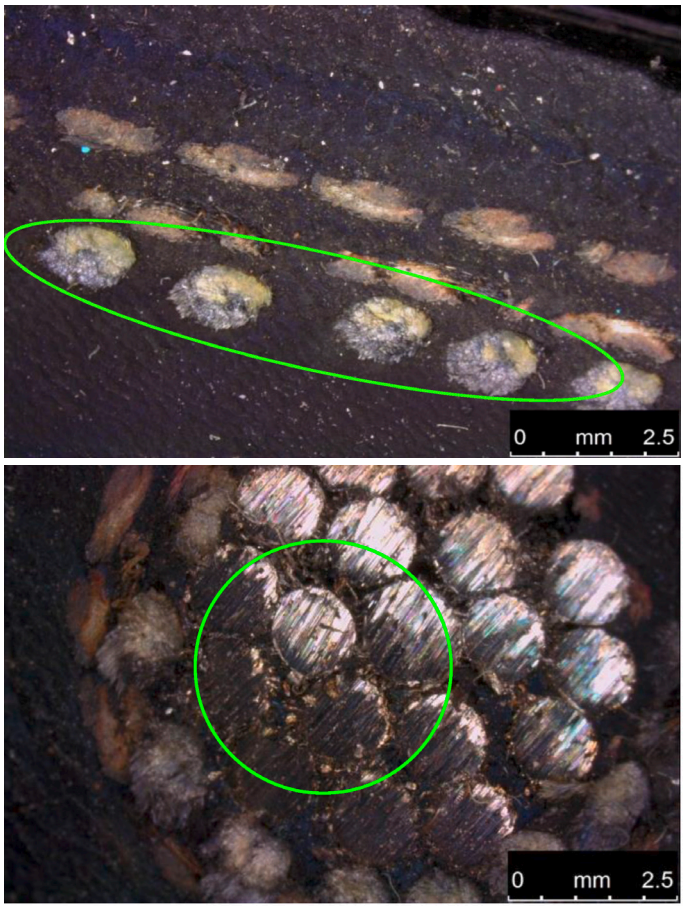
Car air outlet panel, tilt angle -15°: flaw clearly seen in tilted view

Leica DVM6 Digital Microscope: Sample Lighting with Multiple Contrasts Integrated Illumination

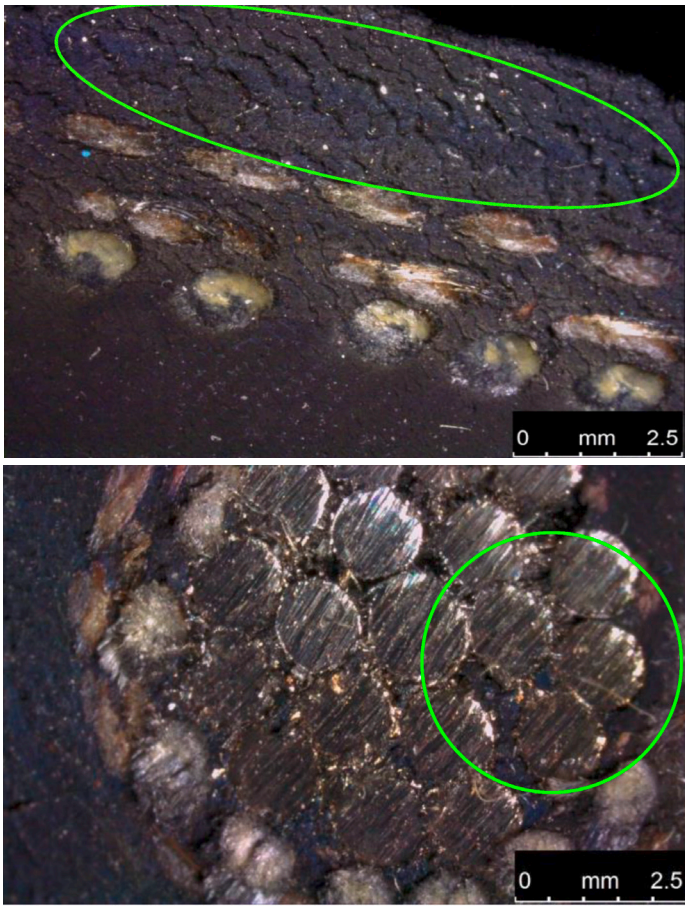
The integrated LED ring light and coaxial illumination of the Leica DVM6 allow several types of contrast methods to be used easily and rapidly These contrast lighting methods make the observation of fine details on the sample simpler. Normally such details are difficult to see. The main contrast methods available with the integrated illumination are brightfield, darkfield, grazing incidence, and quarter waveplate polarization.

In Live mode using the Image Preview function, LAS X can automatically acquire six different images using some preset lighting scenarios, e.g., illumination type, light intensity, exposure time, contrast, HDR imaging, etc. You can then decide which of the six images best suits the current sample and use it as the starting point for your image acquisition. You can either use a preset as is, or fine-tune it to optimize the image displayed in Live mode.

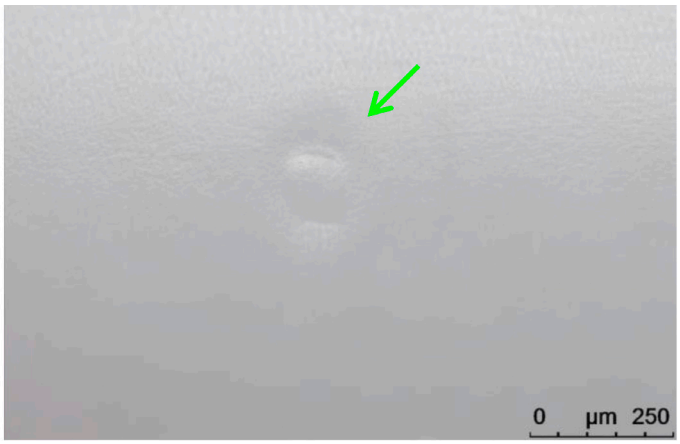
The image preview mode allows users to see the effect of different lighting, contrast, etc. on the acquired images in a more efficient manner. Images of the metal wires, non-metal threads, and rubber seen in the cross section of an automobile tire and an area of a plastic car air outlet panel showing a defect are shown below. The images were recorded with the Leica DVM6 using the integrated illumination in the modes indicated below:



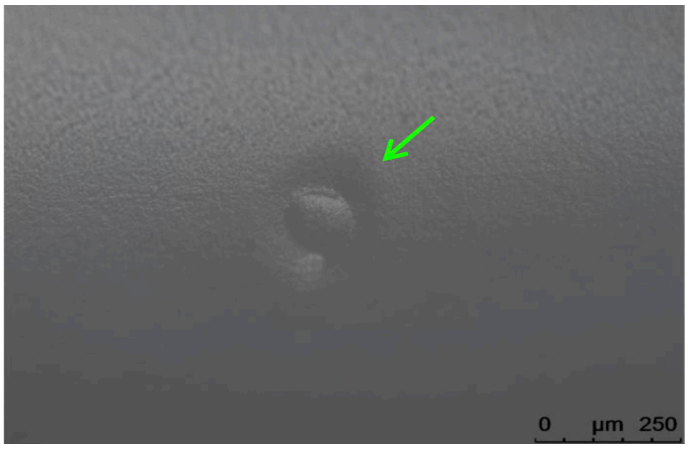
Full ring light illumination of automobile tire cross section: center features highlighted due to back reflection



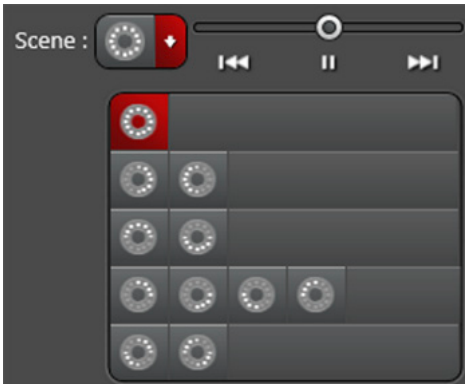
Quarter ring light illumination of the same tire cross section shown to the left: side features highlighted due to grazing incidence

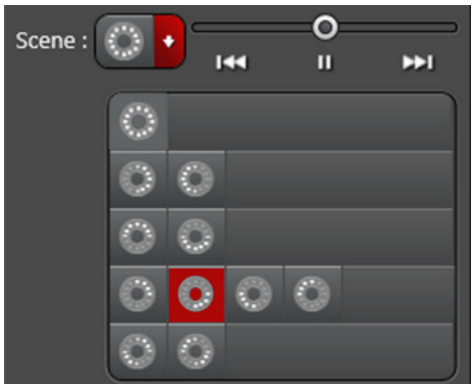


Full ring light illumination of an area with a defect on the plastic car air outlet panel

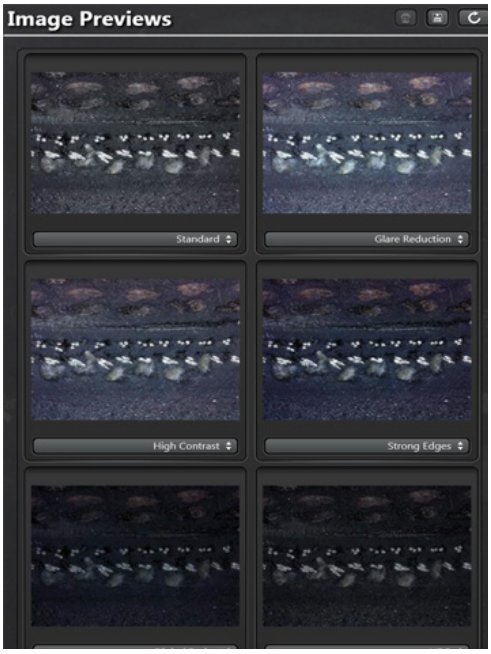


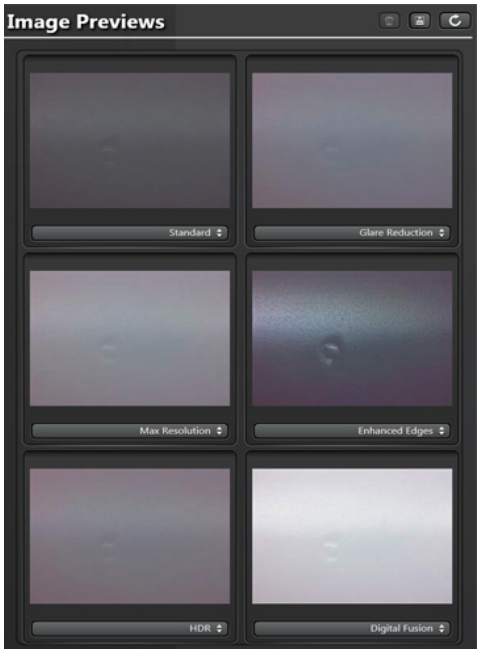
Quarter ring light illumination of the same air outlet panel shown above: better contrast for surface flaws



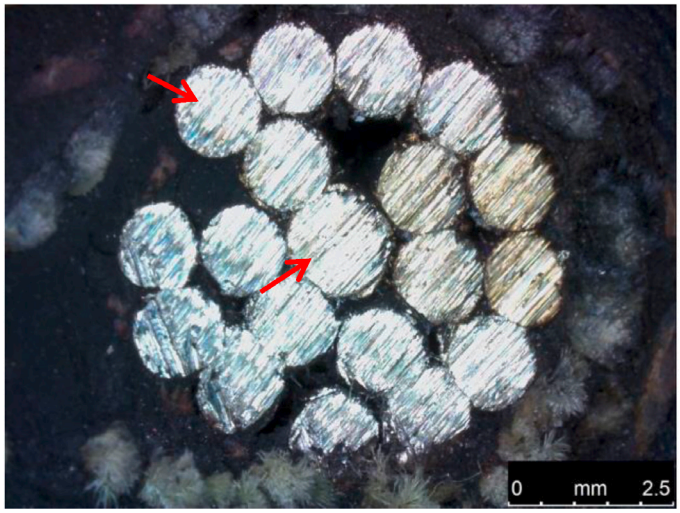


Leica LAS X software scene selection full and quarter ring light illuminationion

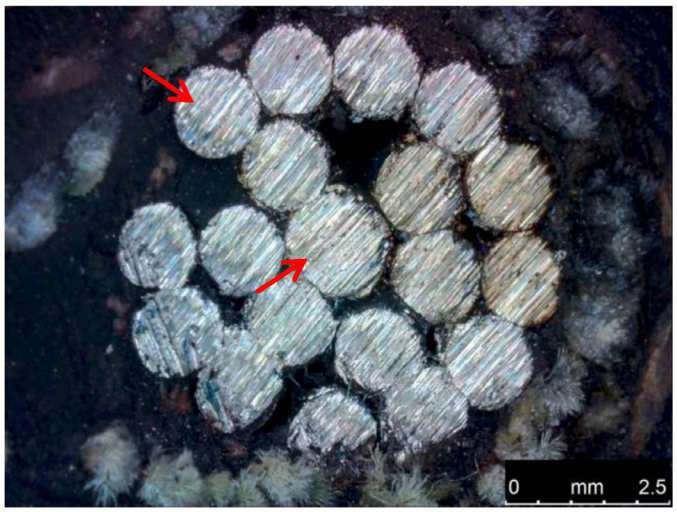




Leica LAS X image previews: 6 images of tire cross section and air outlet panel (small defect) with different types of lighting, contrast, etc.



Tire cross section image without high-dynamic range (HDR)



Tire cross section image with HDR: less glare from reflective metal

Summary

Many solutions are available for inspection, quality control (QC), and failure analysis (FA) of automobile parts, such as tires and car air outlet panels. The Leica DVM6 digital microscope offers users the advantages of encoding, fast magnification change, a 10 MP camera, intuitive software, etc. As shown above, the Leica DVM6 tilting capability and versatile, integrated illumination are quite effective when examining hard-to-image samples, such as black rubber automobile tires and white plastic car air outlet cover panels.

Acknowledgements

We would like to thank Giancarlo Parma (Leica Microsystems, Italy) for supplying the tire samples.

Additional Reading

Leica DVM6 Digital Microscope Product Page

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