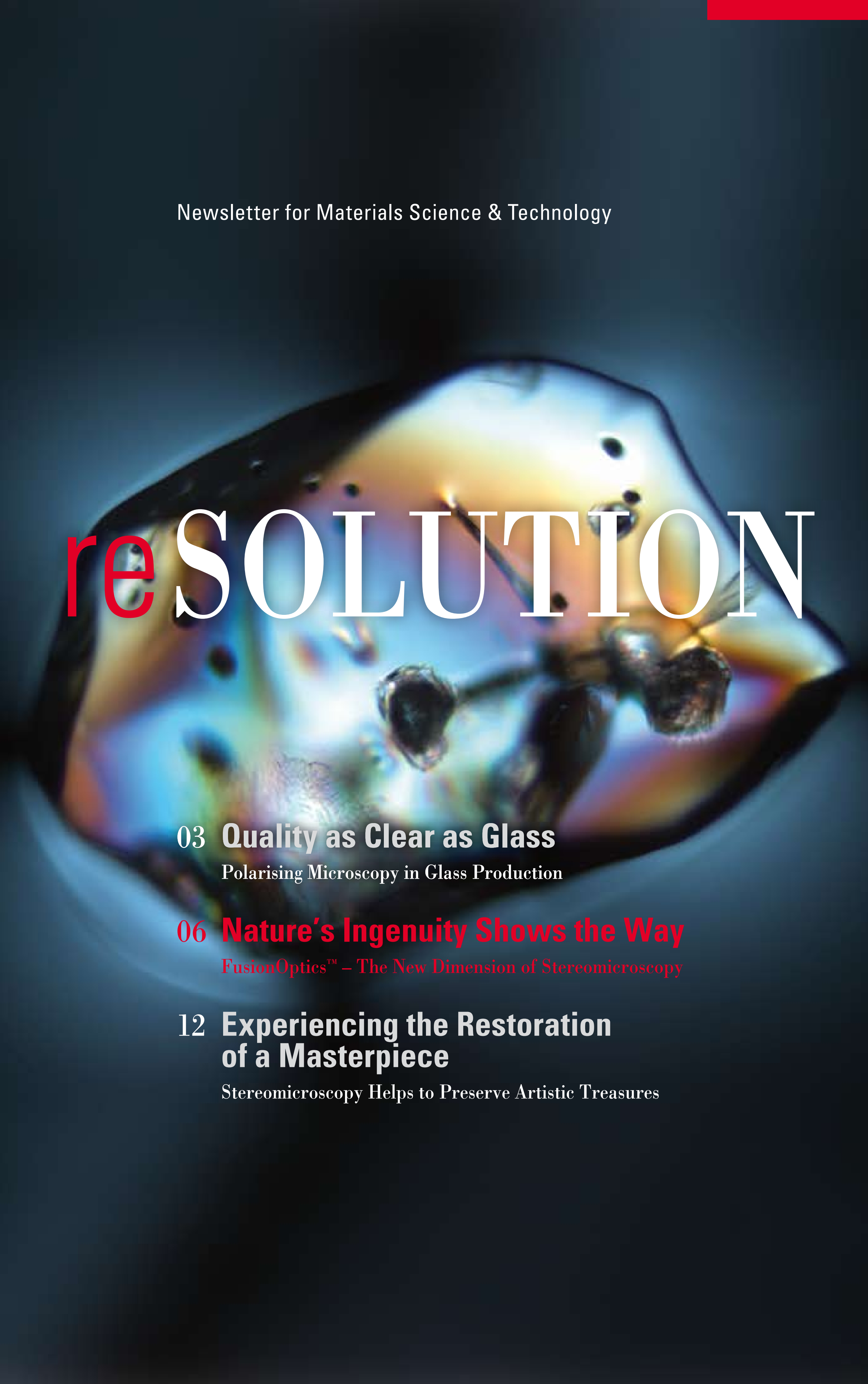
2008

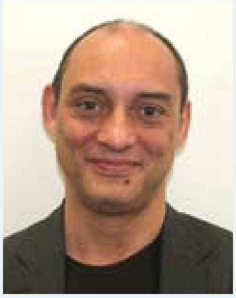
Issue
01

Newsletter for Materials Science & Technology

reSOLUTION



EDITORIAL



Dear Readers,

From the flint stone to the laser beam, from the hand axe to the robot – since the Stone Age, knowledge of materials and their properties has had a decisive influence on our lives. In our modern industrial society, new materials are important drivers for new markets. On the other hand, current trends mean continuously changing requirements for materials. Only if the composition and function of tools can be controlled down to the smallest detail can new materials be developed and end products meet the highest quality standards.

Microscopy plays an important role in many areas, from development to quality control. The automotive and glass industries are just two examples we discuss in this issue of reSOLUTION. However, microscopic material examinations also help us to better understand our own history, as the article about the restoration of a 400-year-old painting demonstrates.

With this, the first issue of reSOLUTION for Materials Science & Technology, we are launching a new edition that will appear twice a year as a printed edition and as a PDF available for download from our website. We will focus on light microscopy methods, application reports and new products for industry, research and related areas involved in materials analysis. Because the subject matter is so wide-ranging, we will certainly not run out of material for future issues.

We are eager to hear what you think of reSOLUTION and which topics you want to read about in coming issues. Give us your opinion – and read what, and how, you can win in the process on page 17.

Have fun reading!

Anja Schué
Corporate Communications

Danilo Parlatano
European Marketing Manager Industry

CONTENTS

Cover picture: Polarisation microscopic image of a glass inclusion with high photoelasticity in surrounding glass (Photo: Klaus-Peter Martinek)

Polarising Microscopy in Glass Production

Quality as Clear as Glass

Klaus-Peter Martinek

An exquisite beverage deserves a high-quality glass. Even the ancient Romans made artistically crafted drinking glasses. In the Middle Ages, Venetian glass-makers were famous for the purity of their glass. One of the oldest materials known to man, glass is used today in many areas, in which it must meet the most stringent quality standards. Light microscopy, for example, would be impossible without special types of optical glass. For quality assurance in the production of flat glass, hollow glass and pressed glass, polarising microscopy enables fast and cost-effective diagnostics of crystalline inclusions without time-consuming specimen preparation.

Though silicate glass can differ greatly in its composition and properties, possible defects are of similar types and causes. In addition to gaseous inclusions (bubbles), crystalline glass defects are common in everyday production. Quick defect identification is critical so that appropriate measures can be taken.

Crystalline glass defects according to their origin:

- Melt-resistant contaminants of the raw materials and old recycled glass
- Non-melted raw material components
- Corrosion residue of fireproof mineral materials from the smelter
- Devitrification products

Quick and reliable fault diagnosis

Distinction between crystalline inclusions and gas bubbles or processing defects takes place using either automatic inspection and sorting systems or by manual sorting after visual inspection. Segments cut out using a glass cutter or diamond saw can usually be inspected microscopically without further processing. For large, opaque "stones", the defect is ground and diagnostics are carried out in incident light. Smaller inclusions in glass knots often cannot be brought into sharp focus due to the lens effect of the glass bead. Therefore the knot is covered with an immersion solution that has the refractive index of the glass (Fig. 1). Furthermore, the microscope configuration presented here also permits quantitative polarised optical measurements; however, this requires flat polished sections of a defined thickness [1, 2, 3].

For nondestructive diagnostics at high magnification of defects located several millimetres under the glass surface, we recommend using the L objectives with extra-large working distance. The 40x Pol objective with coverslip correction is used in addition to the 10x Pol objective for quantitative measurements of thin-section specimens and for conoscopic examinations.

Photo: Nachtmann Bleikristallwerke GmbH

Microscopic equipment for glass examination:

Polarising microscope with:
- Transmitted light bright field, polarisation
- Lambda plate
- Incident light bright field, polarisation
- Oblique incident illumination (cold light lamp, 2/3-arm flexible light guide)
- Widefield eyepieces HC Plan10x (22)

Objectives, preferably with extra-large working distance:
- HC PL Fluotar 5x/0.15/– (12.0 mm)
- HC PL Fluotar Pol 10x/0.30/– (11.0 mm)
- N Plan L 20x/0.40/0 (10.8 mm)
- N Plan L 50x/0.50/0 (8.2 mm)

Objective C Plan Pol 40x/0.65/0.17

Leica DFC420 digital camera

Leica Application Suite (LAS) software package

Fig. 2: The latest-generation polarising microscope: Leica DM2500 P

In transmitted light bright field, the shape, colour and relative refractive index of the surrounding glass can be determined by relief of the inclusion. Decentring the condenser or introducing variable-opening shutters allows oblique illumination for contrast enhancement. Oblique illumination creates strong relief streaks that are virtually invisible with optimally set Köhler illumination.

In transmitted light polarisation contrast, isotropic and anisotropic materials can be differentiated. For idiomorphic crystals, the extinction position can be determined and using the lambda plate, the order of the birefringence can be estimated. Incident light bright field and incident light polarisation contrast are suitable only for defects on the glass surface or for ground specimens. Oblique incident illumination combined with transmitted light allows surface details and colours of the inclusions to be identified.

Examples of crystalline inclusions

Tin oxide (SnO_2)

The heating electrodes of some smelters consist of melt-resistant tin oxide. In case of overload, electrode material can flake off, resulting in the typical aggregates of blue, xenomorphic grains (primary tin oxide). At high temperatures, these dissolve after a little while, forming what is known as a knot. At a lower temperature, long prismatic tin oxide crystals (secondary tin oxide) can grow as thin needles (Fig. 3) or felt-like aggregates (Fig. 4).

Zirconium oxide (ZrO_2) and corundum (Al_2O_3)

Zirconium oxide and corundum are components of the fireproof minerals in smelters (Fig. 5). Under normal loads, the resistant zirconium oxide dissolves in a slow, "well-tempered" manner. Large amounts of zirconium oxide glass defects indicate strong local corrosion, such as that due to thermal overload or excessive flow. Zirconium oxide occurs in its original compound as small white inclusions or forms typical dendritic crystals (Fig. 6). Al_2O_3 is more easily dissolved in the glass melter and usually forms glass knots and streaks. However, corundum can also take the form of rounded grains with typical inclusions (Fig. 7).

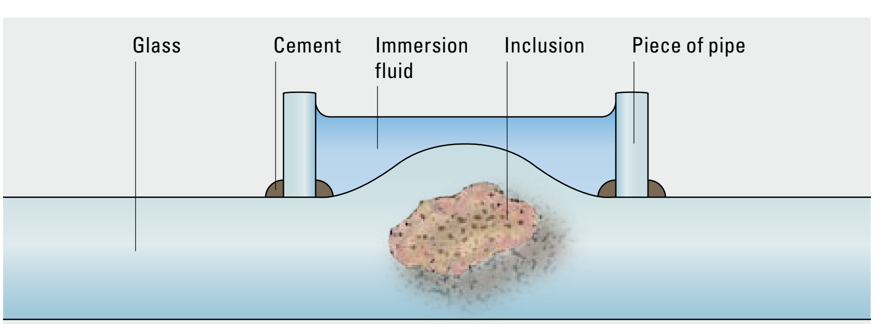
Tridymite/cristobalite (SiO_2)

Tridymite, and less frequently, cristobalite, forms as a devitrification product on SiO_2-enriched glass, for example when volatile components such as alkalis or boroxide evaporate. Tridymite forms typical crystal aggregates with 60° angles (Fig. 8).

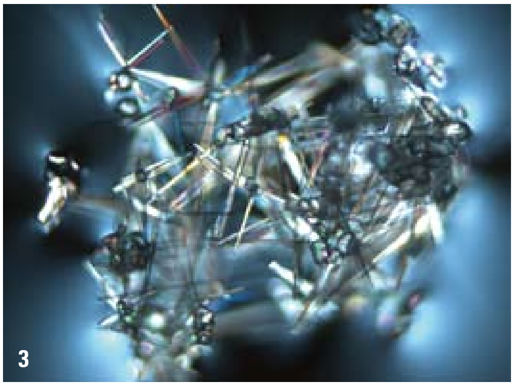
References

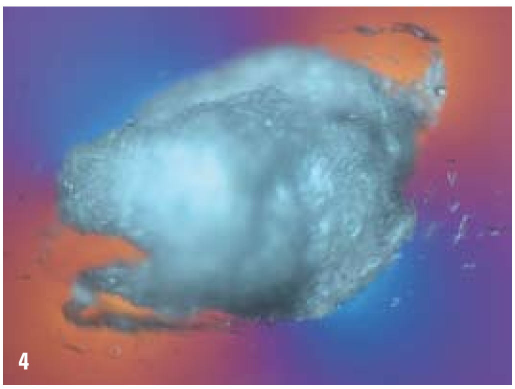
1. Jebsen-Marwedel, H., Brückner, R.: Glastechnische Fabrikationsfehler. 3rd edition, Springer Verlag, Berlin, Heidelberg, New York 1980, VIII + 623 pp.
2. Clark-Monks, C., Parker, J.M.: Stones and Cord in Glass. Society of Glass Technology, Sheffield 1980, VIII + 200 pp.

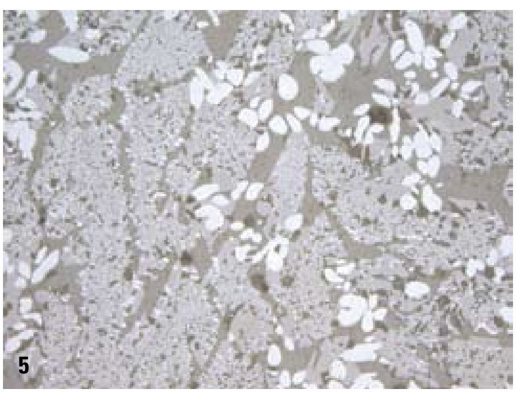
Fig. 1: Optical elimination of the lens effect of a glass knot by immersion in a glued-on piece of pipe (graphic to [1], image 3.63)

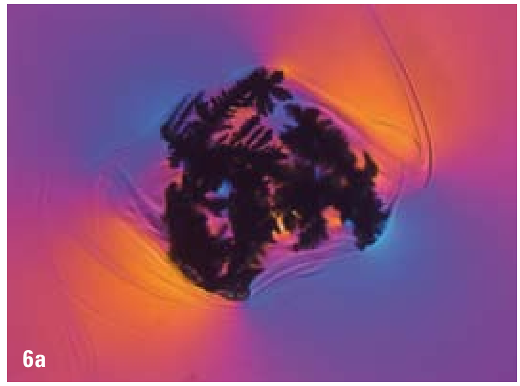


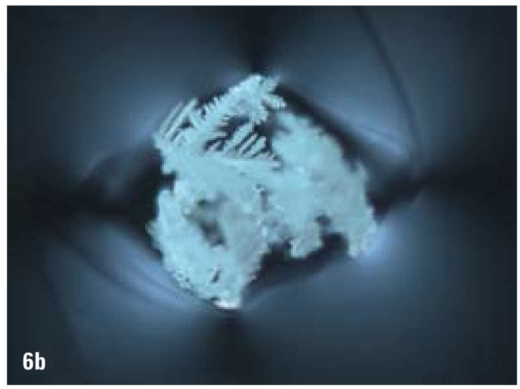
Photos: Klaus-Peter Martinek

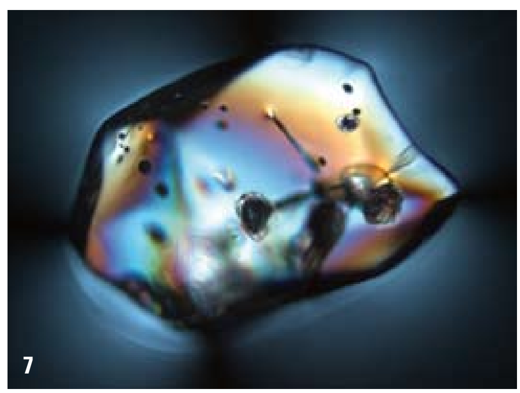












Left:

Fig. 3: Blue granular tin oxide as remains next to needle-shaped recrystallisation product. Glass inclusion with strong photoelasticity in the surrounding glass, transmitted light polarisation contrast, HC PL Fluotar 10x Pol, image width: 1 mm.

Fig. 4: Felt-like aggregate of recrystallised tin oxide. Glass inclusion with strong photoelasticity in the surrounding glass, transmitted light polarisation contrast + lambda plate + oblique incident illumination, HC PL Fluotar 10x Pol, image width: 1 mm.

Fig. 5: High-temperature-resistant fireproof mineral of corundum (light gray bars) and zirconium oxide (white egg-shaped inclusions). Polished specimen in incident light, HC PL Fluotar 10x Pol, image width: 1 mm.

Right:

Fig. 6a: Recrystallised zirconium oxide forms typical crystal aggregates in a knot. Glass inclusion with high photoelasticity in the surrounding glass, transmitted light polarisation contrast + lambda plate, HC PL Fluotar 5x, image width: 2 mm.

Fig. 6b: Recrystallised zirconium oxide forms typical crystal aggregates in a knot. Glass inclusion with high photoelasticity in the surrounding glass, transmitted light polarisation contrast + oblique incident illumination, HC PL Fluotar 5x, image width: 2 mm.

Fig. 7: Primary corundum with numerous inclusions. Glass inclusion with strong photoelasticity in the surrounding glass, transmitted light polarisation contrast, HC PL Fluotar 10x Pol, image width: 1 mm.

Fig. 8: Tridymite dendrites in typical formation. Glass inclusion, transmitted light bright field + oblique illumination for contrast enhancement, HC PL Fluotar 10x Pol, image width: 1 mm.

3. Begley, E.R.: Guide to Refractory and Glass Reactions. Cahner's Publishing Co., Boston, Mass. 1970, IX + 149 pp.

This article appeared in unabridged form in: QZ Qualität und Zuverlässigkeit 3/2008, Carl Hanser Verlag GmbH & Co. KG, Kolbergerstr. 22, D-81679 Munich, Germany, www.qm-infocenter.de

Contact

Graduate Mineralogist Klaus-Peter Martinek was, until January 2008, head of the Research and Development Department at Nachtmann Bleikristallwerke GmbH, Neustadt/Waldnaab, Germany: kpmartinek@t-online.de

FusionOptics™ – The New Dimension of Stereomicroscopy

Nature's Ingenuity Shows the Way

Daniel Göggel, Anja Schué

Up to 80 percent of our experience of our visual environment takes place via our visual perception. Without spatial vision, we would hardly be able to stay oriented. In recent decades, the neurosciences have gained many insights into the complex processes by which our brain's visual cortex and cerebral cortex do the fascinating job of processing the signals originating from the eyes into an image. A study carried out jointly by Leica Microsystems and the Institute of Neuroinformatics at the University of Zurich and Swiss Federal Institute of Technology showed how flexibly and powerfully our brain joins visual signals to create an optimal spatial image. The results provided the basis for an innovation in stereomicroscopy which, in terms of resolution and focus depth, has broken through limits that were previously impossible to overcome.

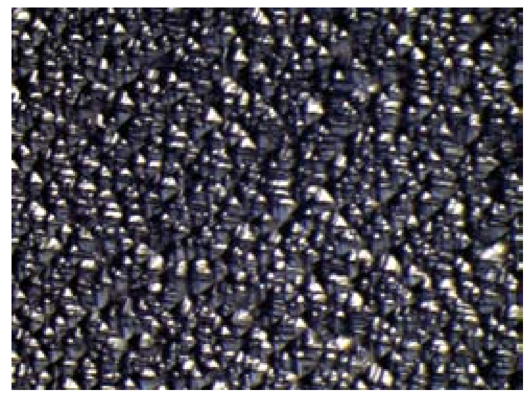


Fig. 2: Silicon surface with chemically etched pyramids a few microns high (photo: Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany)

Stereomicroscopy enables us to view microstructures in 3D with the help of two separate beam paths – which, in principle, work like an extension of our two eyes. Ever since their invention by Horatio S. Greenough, stereomicroscopes have worked according to the optical principles based primarily on Ernst Abbe's work. For over a century, optics designers have worked to push magnification, resolution and image quality to the limit permitted by optics. These limits are determined by the correlation between resolution, convergence angle and working distance. The higher the microscope resolution, the higher the convergence angle between the left and right beam paths and the lower the available working distance. However, increasing the distance between the optical axes would cause the three-dimensional image seen by the observer to become distorted; a cube in the object would then appear as a tall tower. A greater zoom range alone is of little use, since with increasing magnification, there is not an attendant increase in optical resolution. The result is what is known as empty magnification.

Fig. 1: Bearing seal of a truck: rubber wear after stress test

Limits are made to be broken

Scientific studies about visual perception and vision problems have shown that the brain can selectively process information from individual eyes and that it is very capable of compensating for differences in the visual acuity of the two eyes. This gave the development engineers at Leica Microsystems a simple but ingenious idea. Why not make use of this

Fig. 3: Defective through-connection

ability of the brain and use each beam path of the microscope for different information? One image channel provides high resolution, the other depth of field. The two very different images are merged to a single, optimal spatial image by the brain. This completely new optical approach – patent pending under the name FusionOptics™ – brings with it two distinct advantages. Compared to existing stereomicroscopes, the resolution can be increased drastically and the focus depth can be improved significantly. Furthermore, the resolution can be increased without increasing the convergence angle between the two beam paths.

Scientific study confirms new approach

However, the feasibility of this design first had to be reviewed in the light of neurophysiology – whether the brain can process signals that differ greatly between the two eyes into correct three-dimensional images. Earlier studies were primarily concerned with two-dimensional images. Leica Microsystems presented the idea to Dr. Daniel Kiper of the Institute of Neuroinformatics at the University of Zurich and Swiss Federal Institute of Technology, who specialises in researching signal processing in primate brains and agreed to carry out corresponding studies. Kiper, along with Graduate Assistant Cornelia Schulthess and Dr. Harald Schnitzler of Leica Microsystems, designed a study. 36 test subjects with normal visual acuity underwent psychophysical tests that investigated the binocular combination of visual signals. Of particular interest was whether an interocular signal suppression takes place when both eyes are exposed to different stimuli. The result of this would be that the image of the suppressed eye would be perceived only partially or not at all.

During the experiments, the test subjects observed patches arranged around a central fixation point. The fields either had grating or were uniform (Fig. 4). To create differences in the spatial percep-

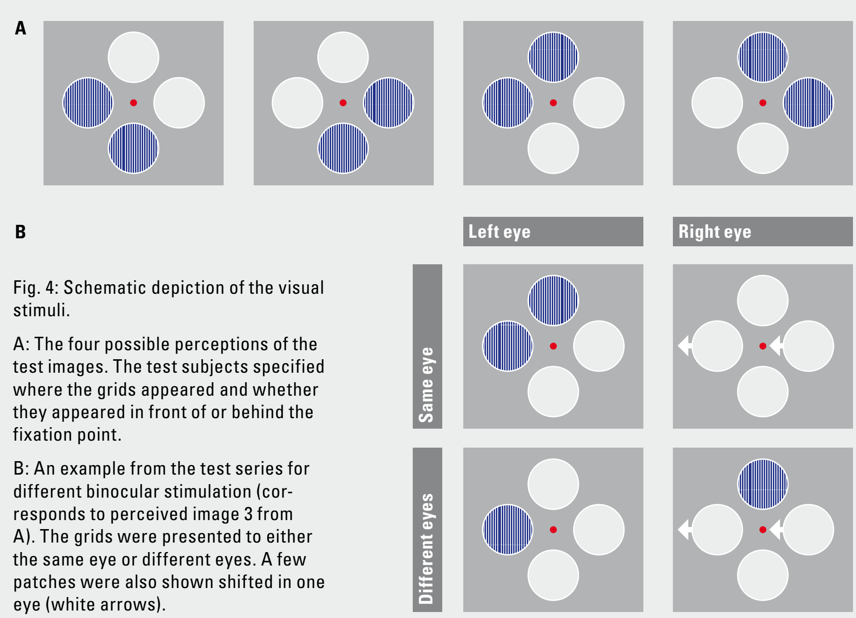


Fig. 4: Schematic depiction of the visual stimuli.

A: The four possible perceptions of the test images. The test subjects specified where the grids appeared and whether they appeared in front of or behind the fixation point.

B: An example from the test series for different binocular stimulation (corresponds to perceived image 3 from A). The grids were presented to either the same eye or different eyes. A few patches were also shown shifted in one eye (white arrows).

Fig. 5: Aggregated aluminium oxide crystals of abrasive cloth. The crystal dimensions allow different grinding capabilities.

tion of both eyes, binocular disparity is required – both eyes must be exposed to different stimuli. This is done using special stereo goggles with which separate test images can be projected to each eye. In a series of trials, the test subjects saw changing arrangements of the grid patches in various depth planes. After each image that was visible for 1,000 msec, the subjects reported where they saw the grid patches, and whether they appeared in front of or behind the central fixation point.

The evaluation of the correct/incorrect answers for the position of the grid patches and the spatial resolution in various spatial planes showed no significant differences. No evidence of signal suppression was observed in any of the tests. This means that the human brain is capable of using the best information from both eyes in order to compose an optimal spatial image. This is true regardless of whether the images are acquired using both eyes or each eye provides entirely different information. The results prove once again how adaptable and powerful our brain is in processing visual impressions.

FusionOptics™ provides one-of-a-kind 3D images

On the theoretical basis provided by the study, Leica Microsystems was able to implement the Fusion Optics™ concept in a completely new stereomicroscope: The Leica M205 C is the world's first stereomicroscope with a zoom range of 20.5:1 and a resolution of up to 525 lp/mm (Fig. 7). This corresponds to a resolved structure size of 952 nm. When appropriately configured, this can be increased to up to 1,050 lp/mm (structure size of 476 nm). Up until now, optical attachments could only achieve a maximum zoom range of 16:1 or a magnification increase without an increase in resolution (empty magnification).

The significant performance increase attained by FusionOptics™ is highly valuable for everyday work at the microscope. The large working distance of the new objective generation allows convenient freedom of movement for examining specimens on the microscope stage. Whether in semiconductor technology, plastics development, materials testing, criminology, natural sciences or earth sciences – the Leica M205 C opens up frontiers that were previously been unattainable in conventional stereomicroscopy.

Contact

Dr. Daniel Kiper, Institute of Neuroinformatics at the University of Zurich and Swiss Federal Institute of Technology: kiper@ini.phys.ethz.ch

Fig. 6: Dr. Daniel Kiper and Cornelia Schulthess

Fig. 7: The new Leica M205 C high-performance stereomicroscope, based on FusionOptics™

New Digital Colour Cameras

Efficient and Convenient Documentation

Without professional image analysis and documentation, reproducible results are impossible. The new digital FireWire colour cameras from Leica Microsystems enable fast and easy image acquisition, image analysis, measurements and documentation and are ideally matched to Leica microscopy systems.

Live images in high-definition quality

Presenting high-resolution microscopic live images in 720p (HD ready) or 1080p (full HD) HDTV format on a flat screen, with simultaneous reproducible analysis and documentation via computer, is possible for the first time with the Leica DFC290 HD. The camera can be used entirely on its own, without a computer, and displays a high-definition colour image immediately after the power supply is switched on. This makes this digital camera an ideal instrument wherever microstructures are presented or discussed.

The Leica DFC290 HD features an impressive light-sensitive sensor with a resolution of three megapixels and high-performance electronics in the camera head for high-quality colour calculation and complex signal generation. The camera enables you to reproduce ultra-sharp, high-contrast images with the smallest details and save them for further analysis.

Fast live images in the best colours

For advanced documentation and analysis, the new Leica DFC400 provides very fast live image display at up to 40 colour images per second with the highest colour fidelity and detail accuracy. The camera offers outstanding image quality and very high light sensitivity due to its large pixels with an edge length of 4.65 µm. The progressive scan method allows time-critical applications and video clip recording. With a maximum resolution of 1.4 megapixels, the individual image shots, of which there are so many in typical situations, are exceptionally well suited for further analysis.

Both cameras use the new FireWire 1394b transmission standard with a speed of 800 Mbps, which, however, is downward-compatible with the commonly used FireWire 1394a standard. Leica digital cameras are equipped with a powerful standard software package, which can be customised to individual requirements in almost any way desired with application-oriented add-on software modules.

The Leica DFC290 HD high-definition colour camera can also be used entirely on its own, without a computer.

Integrated LED Illumination for Stereomicroscopes

Brighter, Faster, More Reproducible

Detecting ultra-fine structures, identifying the smallest scratches or dust particles in incident light quickly and accurately – these tasks require more than a high-performance stereomicroscope and trained eyes. Optimum illumination is the key to even more details and the best possible results. With the new Leica LED5000 RL and Leica LED5000 MCI™ LED illumination modules, material samples appear in a new light.

Fingerprint on a CD in oblique light

The new LED modules are integral components of the Leica M-series. They can also be controlled by computer using the Leica Application Suite (LAS) software. If a Leica camera is used, all illumination settings can be saved along with the acquired image and reproduced at the touch of a button for recurring experiments.

Save time and costs

Gone are the days in which the external light source had to be readjusted by hand when scanning specimens. Latest-generation LEDs provide constant, daylight-like conditions. With a life of over 25,000 hours, lamp replacement is unnecessary. The specimen is not heated, and with an energy saving of 90% compared to a 150-watt halogen lamp, the LEDs help to protect the environment. An additional benefit is that the workstation remains neat and tidy – without cables and power supplies for the external light sources.

The ring light for the best views of the specimen

The Leica LED5000 RL ring light illuminates a specimen with up to 48 LEDs and provides a very bright,

Illumination scenarios with the Leica LED5000 RL: all 48 LEDs / 2 x semicircle segments / 4 x quartercircle segments

The Leica LED5000 MCI™ specializes in flexible oblique illumination

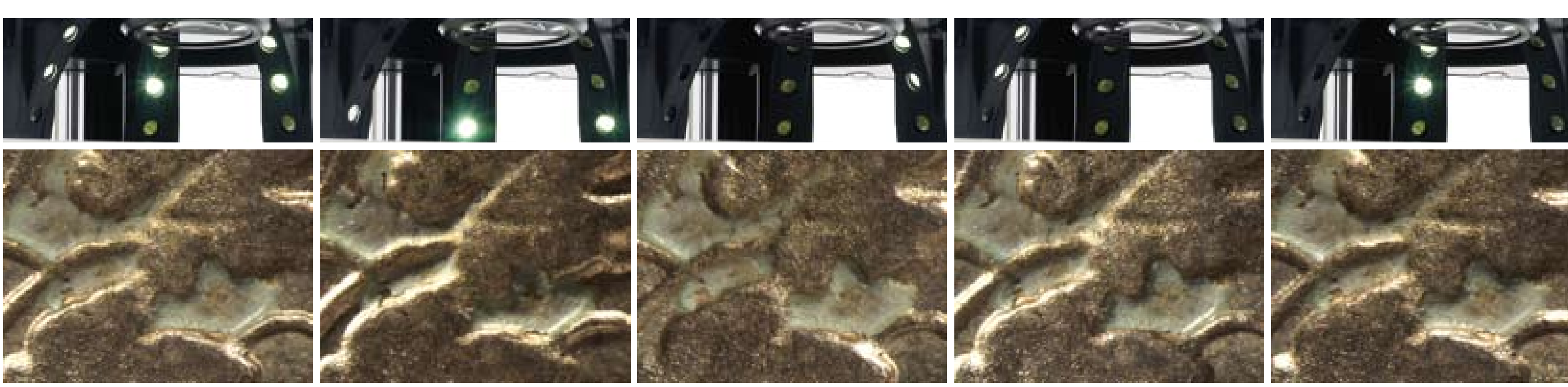
uniform light. Various illumination perspectives and scenarios can be realised by switching quarter-circular or semicircular segments differently. In addition, using LAS, you can define how quickly to toggle between scenarios.

The oblique light for the correct angle

The Leica LED5000 MCI™ developed by Leica Microsystems for "Multi Contrast Illumination" specialises in flexible oblique illumination. Three illuminator arcs contain three power LEDs each, which can be activated differently. The specimens can be illuminated in an angle between 15° and 40° to make more details visible by means of changes in contrast. Furthermore, the two outer arcs can be moved as desired on the guide rail and form an angle of up to 90°, allowing you to discover even the smallest details.

Fingerprint in flat oblique light clearly visible: dust particles

Below: Illumination techniques with Leica LED5000 MCI™:
top two LED-rows /
lower LED-rows /
two top LEDs right, middle, left



Stereomicroscopy Helps to Preserve Artistic Treasures

Experiencing the Restoration of a Masterpiece

Jørgen Wadum

We have all admired the paintings of the legendary masters. However, art enthusiasts are not usually familiar with how these centuries-old artistic treasures can be maintained for future generations. Neither are they aware of the methods today's experts use to research old painting techniques. In an open workshop projected to run through June 2008, museum visitors will be able to experience up close the conservation, restoration and research process of one of the most impressive paintings in the Statens Museum for Kunst, the Danish National Gallery, in Copenhagen. Painted by Jacob Jordaens (1593–1678), the 2.80 × 4.67 m work is entitled "The Tribute Money. Peter Finding the Silver Coin in the Mouth of the Fish", also known as "The Ferry Boat to Antwerp" (Fig. 1). An open workshop in the museum has presented exciting insights into the secrets of the masterwork and the techniques used in the conservation and restoration work. Besides the restoration, the project will research materials, techniques, meaning, history of conservation and provenance of the artwork.

Fig. 1: Jacob Jordaens, The Tribute Money. Peter Finding the Silver Coin in the Mouth of the Fish, also called The Ferry Boat to Antwerp. Oil on canvas, 279.5 by 467 cm. Statens Museum for Kunst, inv. KMS3198.

Open workshop provides insights

The museum has decided on the open workshop because, as a National Gallery, it feels an obligation to explain to the public how our cultural heritage is researched and cared for. Another goal is to present all aspects of the conservator's job – from preserving the artworks to developing ideas for using cultural resources.

Supporters include Leica Microsystems, which has donated a stereomicroscope. The microscope is useful, for example, in localising phenomena such as saponifications on the surface of the painting (Fig. 2). Visitors can follow the work live on a 50" plasma screen connected to the microscope. The museum's website, www.smk.dk/restaurering, also invites visitors to follow the progress and respond to the conservators' and art historians' blogs and find answers to a multitude of questions about conservation work.

A complex composition

The painting is composed of eight pieces of canvas of varying size and quality. The painting was originally started on a much smaller scale; Jordaens expanded it during the creative process. The current research could corroborate earlier studies, which have suggested that Jordaens' working method was comparable to that of Pieter Paul Rubens.

Darkened varnish and numerous areas of blanched paint and varnish mar the appearance of the painting. Many faded retouches are the evidence of earlier conservators' work. Blanched areas, both in the varnish and in some areas of the paint, further add to the now hazy and dull appearance of the composition's details.

Fig. 2: The microscopic work in the open restoration workshop in the museum gallery

Original brilliance restored

The first step consists of removing layers of varnish – across some fourteen square metres – as well as the discoloured retouchings. Then, the paint layer is studied carefully. After the cleaning, extensive retouching is needed to close lacunae and adjust transparent or abraded areas in order to give this majestic and spectacular painting the presentation it deserves.

At the same time, Jordaens' painting techniques are being studied to determine which phenomena lead to a loss of quality. This will provide new insights into Jordaens' artistic and technical development and the origin of the 400-year-old painting. In collaboration with the Instituut Collectie Nederland (ICN), the Koninklijk Museum voor Schone Kunsten in Antwerp and the Kunsthistorischen Museum in Vienna, Jordaens' painting technique will be compared to that of his contemporaries.

The painting techniques will be extensively analysed for structure, pigment compositions and binding media (cross section analysis, SEM-EDX; FTIR; GCMS). X-radiography and infrared analysis provide additional information about the condition and origin of the painting. The X-radiograph has already uncovered a surprise: hidden below a cloud in the sky between the sail and the men to the right of the

International advisory body

- Klaes-Jan van den Berg, Instituut Collectie Nederland, Amsterdam
- Mads Chr. Christensen, Nationalmuseet, Brede/Copenhagen
- Beate K. Federspiel, School of Conservation, Copenhagen
- Anne van Grevenstein Kruse, Stichting Restauratie Atelier Limburg, Maastricht
- Margriet Eikema Hommes, University of Amsterdam, Amsterdam
- Nico Van Hout, Koninklijk Museum voor Schone Kunsten, Antwerp
- Paul Huvenne, Koninklijk Museum voor Schone Kunsten, Antwerp
- Mark Leonard, The J. Paul Getty Museum, Los Angeles
- Elke Obertahler, Kunsthistorisches Museum, Vienna
- Mikkel Scharff, School of Conservation, Copenhagen
- Alejandro Vergara, Museo Nacional del Prado, Madrid

Fig. 3: X-ray (detail) with the newly revealed head of a woman painted over.

The project team of the Statens Museum for Kunst: Jørgen Wadum, Keeper of Conservation and Project Leader; Eva de la Fuente Pedersen, Senior Research Curator; Pauline Lehmann Banke, Conservator; Troels Filtenborg, Conservator; and Johanneke Verhave, Conservator

disciple Peter are the complete features of a painted woman (Fig. 3). For the analysis of the surface, a Leica M651 stereomicroscope is being used, which is equipped with a 150 mm objective for large working distances and a floor stand with a flexible swivel arm for horizontal and vertical manoeuvrability.

Answers to many questions expected

The art-historical research will focus on the painting's provenance in the context of the modes of thought and values of the time. The painting is also a deposit of the society of the 17th century, defined by conventions of its time that were influenced by economy, religion, culture and politics, as well as the relationship between artist and client, presumably a guild house or even the Mayor's house in Antwerp.

According to Joachim Sandrart, who described Jordaens' painting in his "Teutsche Academie der Edlen Bau- und Malerey-Künste" (1675-79) as hanging in a long chamber, it represented "the big ferryboat to Antwerp with all kinds of animals and people, who worked according to their specific trade…." However, the painting also portrays a Biblical subject: the disciple Peter finding the tribute money in the mouth of the fish. The story of the temple tribute money is told in Luke 20: 20–26.

What was the meaning of this painting, which is both a scene from everyday life and a work based on the Bible? How did Jordaens' workshop function? Did Jordaens himself paint the entire painting? These are just a few of the many questions the project seeks to answer.

Reference

This article appeared in unabridged form in: RESTAURO 12/2007, Verlag Georg D.W. Callwey GmbH & Co. KG, Streitfeldstr. 35, D-81673 Munich (Germany), www.restauro.de.

Contact

Jørgen Wadum, Chief Conservator, Statens Museum for Kunst, Copenhagen, j.wadum@smk.dk

Leica QClean – Complete System for Residual Dirt Analysis

Cleanliness, the Key to Reliability

Dr. Jürgen Paul

The cleanliness of high-performance and safety-related components is an important factor for long service life and reliability. Quantitative cleanliness analysis has, until now, primarily been used in the automotive field. Today, an increasing number of industries involved in the production of highly stressed components use this method. This trend is accelerated by new quality standards such as VDA volume 19 and ISO 16 232.

Leica Microsystems recognised this trend at a very early stage. For over ten years, we have been developing Leica QClean, a complete system for residual dirt analysis, together with leading automotive industry suppliers. All common industry standards are implemented in their entirety. Furthermore, companies' in-house standards or evaluation procedures can be readily applied.

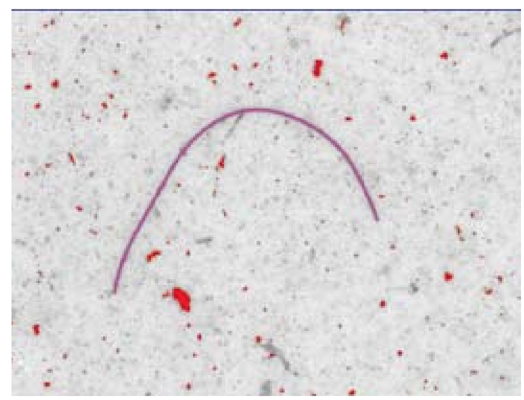


Fig. 2: Detecting and classifying different particle geometries, including bent fibres

Optimum interaction of all components

The complete Leica QClean system consists of a fully automated Leica DM6000 M or DM4000 M incident light microscope with motorised specimen stage and focus, the high-resolution Leica DFC290 digital camera and a high-performance PC. The centrepiece is the Leica QClean control and evaluation software. For all contrast methods such as bright

Fig. 1: Complete Leica QClean system: fully automated microscope, digital camera and software are designed for safe and easy operation.

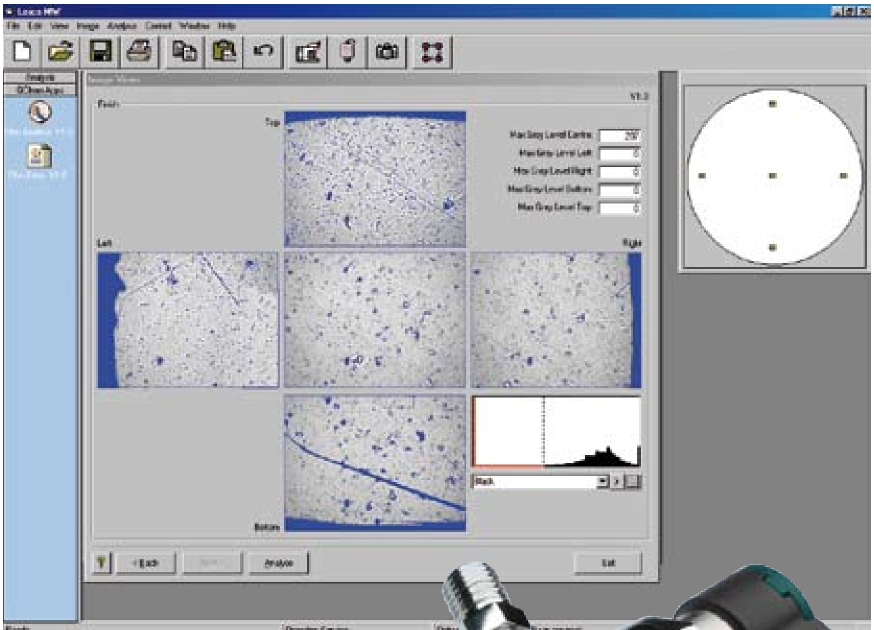


Fig. 3: Relocating measured particles to identify artifacts. These are listed separately and deleted from the measurement results.

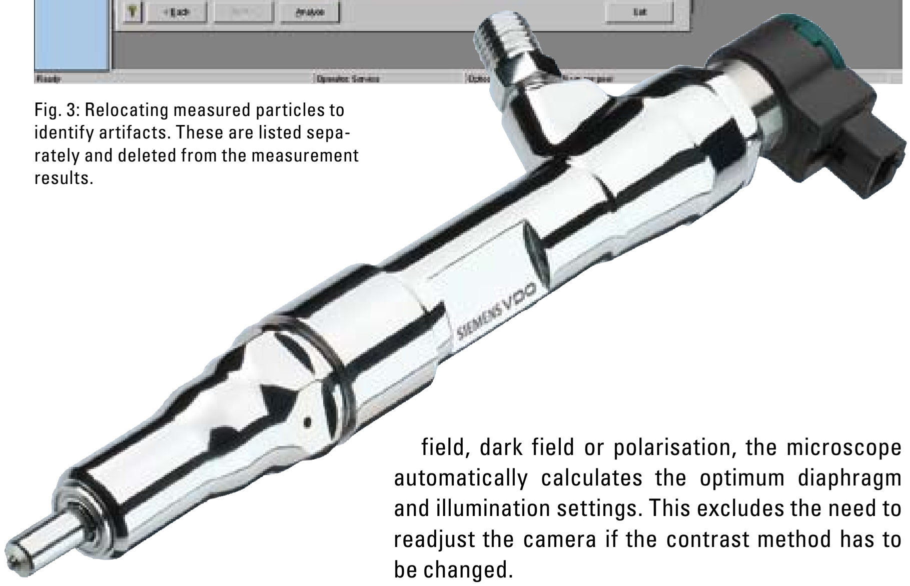


Fig. 4: Piezo common rail diesel injection system (photo: Continental)

field, dark field or polarisation, the microscope automatically calculates the optimum diaphragm and illumination settings. This excludes the need to readjust the camera if the contrast method has to be changed.

The prerequisite for reliable and reproducible particle detection in the entire image field is the interaction of the microscope optics with low shading and the shading correction in the digital camera. Special specimen holders enable accurate centring of the filter. Depending on the particle size, 2.5x, 5x, 10x or 20x objectives are used. If only large particles with a size of 25 or 50 µm or more are examined, the Leica Z6 or Z16 APO macroscopes with manual or motorised zoom, or a Leica stereomicroscope with motorised mechanical stage, are also suitable.

Flexible parameter configuration – easy routine measurements

Leica QClean uses just two operating modes, “Filter setting” and “Routine measurement”. In filter setting mode, all parameters are defined such as filter diameter, measurement standards, typical microscope and camera settings for various filters, particle size classes, particle classification, particle detection, scanning mode, data recording, reporting etc. These settings are optimised once for each filter type and then are valid for all subsequent routine measurements. Any number of filters can be created in the system.

Leica QClean stores all measurement parameters together with the microscope and camera adjustments. All specific data is loaded before the measurement. This “reproducible microscopy” guarantees that measurements can be replicated under constant imaging conditions, making time-consuming fine adjustments of the microscope and camera unnecessary when changing filters. Another important advantage is that no dedicated knowledge is required for routine measurements, which are often carried out around the clock.

The measurement procedure is self-explanatory and makes operator errors virtually impossible. While the measurement is in process, an overview image of the filter appears in which large particles or preparation errors can be detected at an early stage. After the measurement, the results are displayed automatically and can be saved to the integrated archiving system or exported to Word or Excel for further processing. Particles can also be inspected individually, allowing artifacts to be excluded from the evaluation. Images of notable particles can be stored along with their measurement parameters or added to the results report. When the particle data is saved in Excel, deleted particles appear in another list for checking to further reduce the possibility of error.

Large and small at the same resolution

Microscopic particle analysis always has conflicting goals i.e. measuring large and small particles at the same high resolution. If small particles are to be measured accurately, there is a danger that large ones will be cut off from the image field border and only partially detected. Therefore, Leica QClean offers a special mosaic feature, which allows simultaneous measurement of small and large particles that overlap multiple image fields on any size filters. User-selectable measurement parameters are available for differentiation, which can be used to treat virtually any particle shapes and sizes, including bent fibers, as different data records

Versatile application fields

In addition to cleanliness measurement of components such as high-pressure injection pumps, ABS and engine components, Leica QClean is now also being used in the pharmaceutical industry for particle measurement and cleanroom monitoring. Its variable measurement parameters and conditions make Leica QClean ideal for applications such as cleanliness analysis of cleaning agents, coolants and lubricants. Its great flexibility and easy operation make Leica QClean a fast and reliable measuring system for a wide variety of routine measurements and for research tasks.

Reference

This article appeared in unabridged form in:
JOT Journal für Oberflächentechnik 10/2007, Vieweg Verlag/ GWV Fachverlage GmbH , Postfach 1546, D-65173 Wiesbaden, www.all4engineers.com

Contact

Dr. Jürgen Paul, Product Manager,
Leica Microsystems CMS GmbH,
Juergen.Paul@leica-microsystems.com

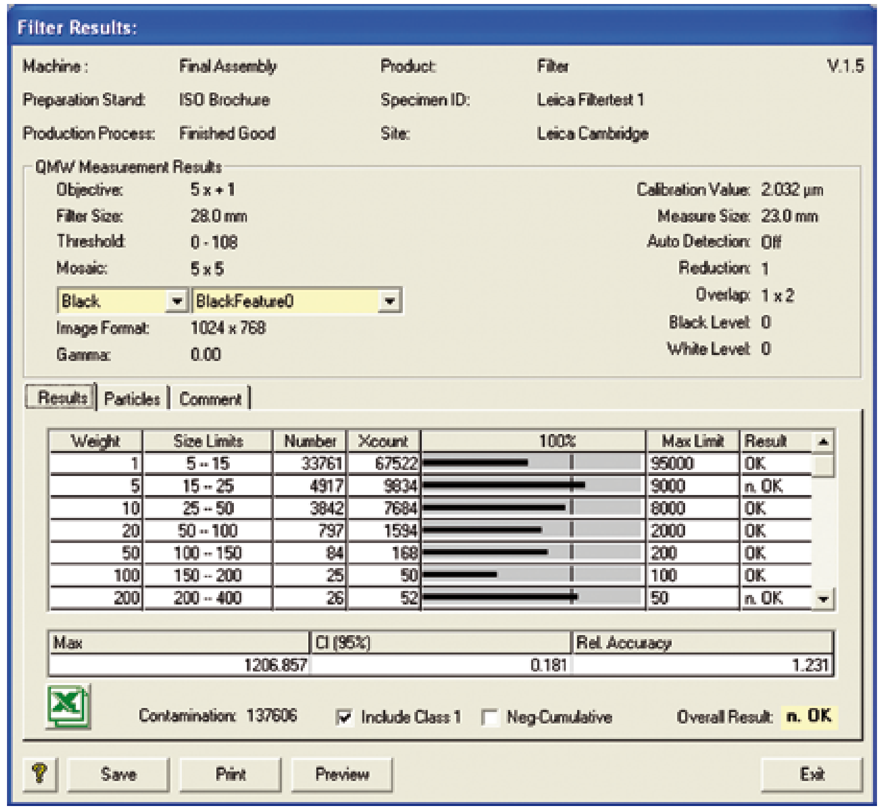


Fig. 5: Complete documentation of all parameters and settings relevant to measurement

Your opinion counts!

Win a cubo Design CD radio & MP3 player!

Dear readers,

Please let us have your comments about the first issue of reSOLUTION Materials Science & Technology. Not only will it provide us with valuable suggestions to improve the magazine; you will also get a chance to win a fabulous cubo Design CD radio with integrated MP3 player. You can access the competition via the following link.
Please enter your comments and your address:

www.leica-microsystems.com/EU-Materials

The winner will be drawn from all complete entries received by 31 August 2008.

Keyword: Resolution & Magnification

Beware of "Empty" Magnification

In the simplest case, a microscope consists of one lens close to the specimen (objective) and one lens close to the eye (eyepiece). The magnification of a microscope is the product of the factors of both lenses. A 40x objective and a 10x eyepiece, for example, provide a 400x magnification.

The light wave defines the limit

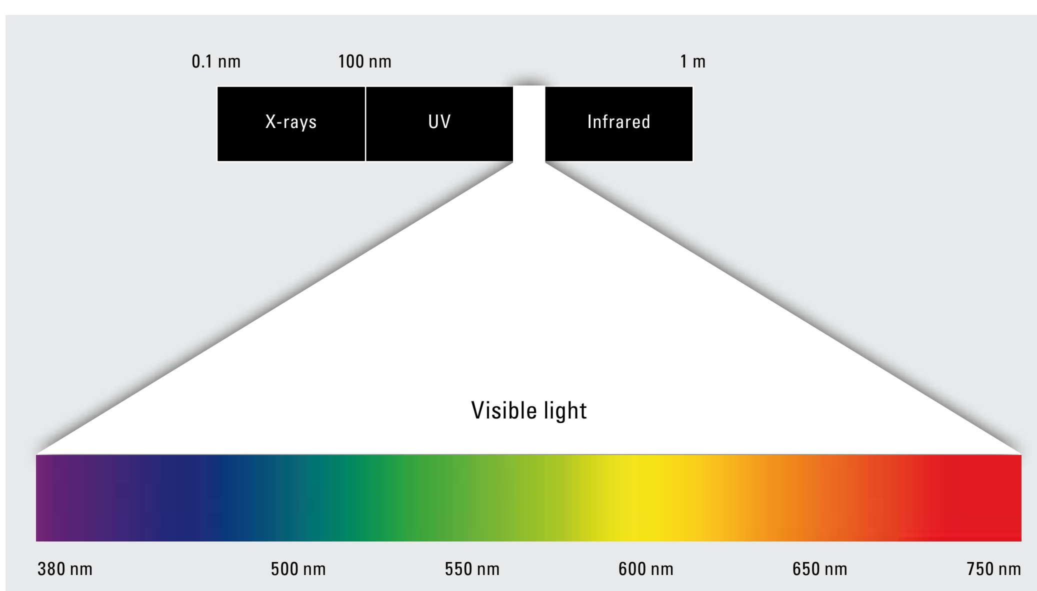
However, it is not only the magnification but also the resolution that indicates the performance capacity of a microscope. Resolution is the ability to render two closely adjacent dots separately. According to the Rayleigh criterion, the minimum distance between two dots able to be separately imaged corresponds to approximately one-half the wavelength of the light.

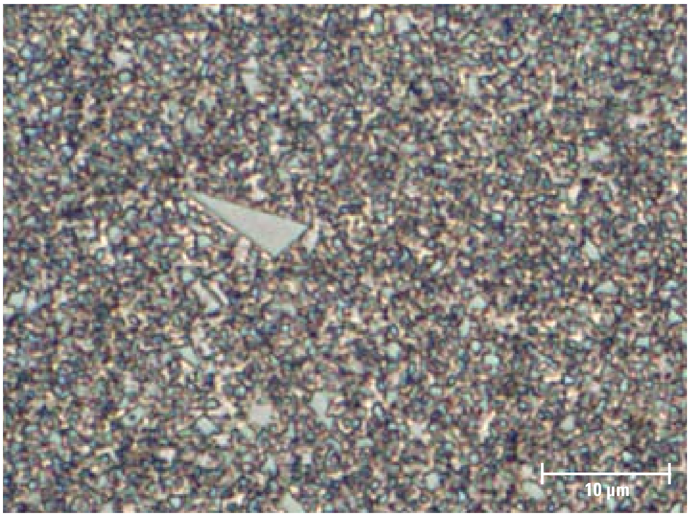
$$d = 0.61 \times \frac{\lambda}{n \times \sin \alpha}$$

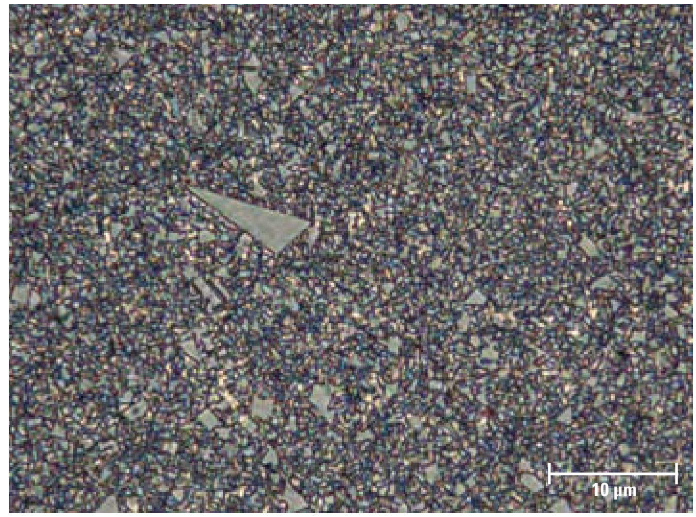
λ = light wavelength
n = refractive index of the medium between specimen and objective
α = half the aperture angle of the objective


Only the interaction of complex lens systems allows optimum image quality.

Therefore, with blue light, the resolution limit is approximately d = 0.2 µm; with red light, around d = 0.35 µm. UV objectives attain a resolution just under 0.2 µm. With the naked eye, we are not able to differentiate structures smaller than 0.2 millimetres.



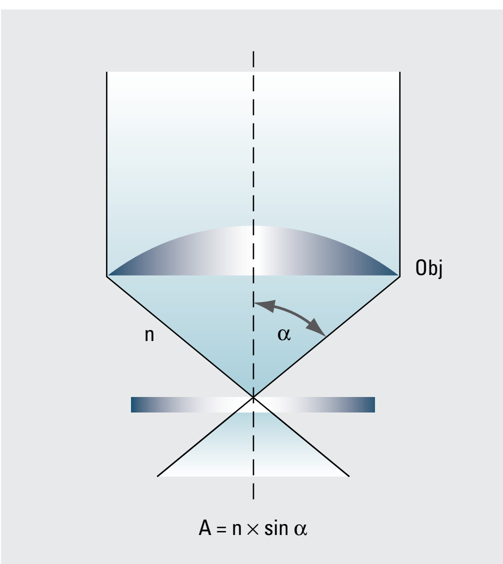




Hard metal with 10 % cobalt (sub-µm structure, 0.6 µm initial grain size) for production of heavy-duty tools, viewed with various objectives:

- left: dry objective, NA = 0.90;
- right: oil immersion objective, NA = 1.30

Courtesy of Konrad Friedrichs GmbH & Co KG, Kulmbach, Germany



The numerical aperture of the objective determines the detail resolution and brightness of the image

The value $n \times \sin \alpha$ corresponds to the numerical aperture (NA), the measure of the light gathering capacity and the resolution of an objective. Because the aperture angle cannot exceed 90° and the refractive index is never less than 1 ($n_{air} = 1$), NA is always around 1 for air. When immersion oil is used ($n > 1$), the numerical aperture increases (to up to approx. 1.45) and, along with it, the resolution.

More magnification is not always better

To make the microscopic resolution detectable to the eye, the image appears in the eyepiece with corresponding magnification. The resolution and magnification are always directly interdependent. An objective with low magnification has a low numerical aperture and thus a low resolution. For a high-magnification objective, the numerical aperture is also high, typically 0.8 for a 40x dry objective. However, because the numerical aperture cannot be increased beyond a certain point, the usable magnification range is also limited in classic light microscopes. The “useful” magnification is between 500 × NA and 1,000 × NA.

Some light microscopes boast enormous magnification, but practically speaking, the limit is just under 1,400x. Specialists call everything beyond that “empty magnification.” Though structures appear larger, but no additional details are resolved.

Events 2008

Réunion des Sciences de la Terre
April 21–24
Nancy, France
www. rst2008.u-nancy.fr

Control
April 22–25
Stuttgart, Germany
www.control-messe.de

Het Instrument
May 20–23
Utrecht, Netherlands
www.hetinstrument.nl

BIAS
May 27–30
Milan, Italy
www.fieremostre.it

SMT
June 3–5
Nürnberg, Germany
www.smt-exhibition.com

Environnement Professionnel Horlogerie Joaillerie (EPHJ)
June 3–6
Lausanne, Switzerland
www.ephj.ch

INTERTECH
June 05–07
St. Gallen, Switzerland
http://www.nanoeurope.com/wDeutsch/messen/intertech/01_besucher/home/home.php

Microscience
June 23–26
London, UK
www.microscience2008.org.uk

Metallographietagung
September 17–19
Jena, Germany
www.dgm.de/metallographie

Biotech Forum & ScanLab
September 23–25
Copenhagen, Denmark
www.scanlab.nu

QualiPro
September 23–26
Dortmund, Germany
www.qualipro-messe.de

MesurExpo
September 30 – October 2
Paris, France
www.mesurexpo.com

BI-MU
October 3–7
Milan, Italy
www.bimu-sfortec.com

Vienna TEC 2008
October 7–10
Vienna, Austria
www.vienna-tec.at

Expoquimia
October 20–24
Barcelona, Spain
www.expoquimia.com

Parts2Clean
October 28–30
Stuttgart, Germany
www.parts2clean.de

Worlddidac
October 29–31
Basel, Switzerland
www.worlddidacbasel.com

EMAF
November 12–15
Porto, Portugal
www.emaf.exponor.pt

PRODEX
November 18–22
Basel, Switzerland
http://www.prodex.ch/htm/willkommen.htm

Leica Workshops

Wetzlar, Germany

May 7–8
Digital Imaging

June 10–11
Light- and Stereomicroscopy

June 12
Quality Assurance Image Solution
Leica QClean

September 2–3
Microscopy and preparation
(Focus: Plastics)

October 13–14
Digital Imaging

October 15–16
Leica QWin Basic Course
Image Analysis

October 21–22
Quips Advanced Course
Image Analysis

Milano, Italy

May 6–7
Advanced Course Image Analysis

Torino, Italy

June 11
Basic Course Image Analysis

Please also visit our website on www.leica-microsystems.com/events for more information on and registration.

Imprint

Publisher
Leica Microsystems GmbH
Ernst-Leitz-Straße 17–37
D-35578 Wetzlar (Germany)
www.leica-microsystems.com

Editors in Chief
Anja Schué, Corporate Communications,
Anja.Schue@leica-microsystems.com

Danilo Parlatano, European Marketing,
Danilo.Parlatano@leica-microsystems.com

Contributing Editors
Daniel Göggel
Dr. Daniel Kiper
Klaus-Peter Martinek
Dr. Jürgen Paul
Jørgen Wadum

Team Members
Michael Doppler
Yves Janin
Petra Kienle
Carola Troll
Sabine Wagner

Layout
Heinz Flick

Cover Picture
Klaus-Peter Martinek

Production
Uwe Neumann,
Corporate Marketing & Identity

Printing Date
18. April 2008