

Nov.
2008
No. 02

NEWSLETTER FOR MATERIALS SCIENCE & TECHNOLOGY

reSOLUTION

Save Our Memory

A Look Inside the Restoration of Historic Photos

Combined Precision for Non-Contact Surface Metrology

The First Dual Core Microscope for
Confocal and Interferometry Profiling

Research for the Optimal Structure

Magnetic Fields Optimise Metal Alloys



Dear Reader,

Type the keyword 'nanotechnology' into Google and you'll get well over 15 million hits. Early in the 21st century people were still talking about the technology of the future. Now nanomaterials are already an integral part of our everyday life: dirt repellent spectacle lenses, windscreens and textiles, scratchproof paints, efficient catalytic converters, transparent solar cells, high-speed cell phone chips or LEDs in traffic lights are but a few of the examples of the many applications of nanotechnology. However, we have only just begun to comprehend and harness the phenomena and laws of nano-science – the fundamental structures and the processes occurring in materials at atomic and molecular level.

Tapping further into the untold potential of new, nanotechnological products calls for new tools capable of measuring and modeling the structures on a scale of one atom to 100 nanometres. The new DCM 3D measuring microscope is just such a tool. Combining confocal and interferometric technology for the first time, it can contactlessly measure surface geometries to a resolution of 0.1 nanometres. And when it comes to preparing specimens for nanometric and microstructural analysis, Leica Microsystems has a range of innovative instruments such as the Leica EM TXP and the Leica EM TIC020.

However, this edition of reSOLUTION is not devoted to the future alone. Remember those old family photographs of your grandparents or great-grandparents; fading photographs in danger of being lost to posterity for ever? To keep these memories alive for future generations, the specialists at Fratelli Alinari utilise cutting-edge technology – such as stereoscopy with all its imaging and documentation applications.

We hope you enjoy this edition of reSOLUTION. In particular, we look forward to your opinions and comments. To find out how to post your opinions and comments, and how we propose to thank you for your feedback, please turn to page 16.

Have fun reading!

Anja Schué
Corporate Communications

Danilo Parlatano
European Marketing Manager Industry

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A Look Inside the Restoration of Historic Photos

Save Our Memory

Sam Habibi Minelli, Alinari 24 ORE

In 1852 Leopoldo Alinari, with his brothers Giuseppe and Romualdo, founded a photographic workshop in Florence, which is at the heart of the firm that still bears his name: Fratelli Alinari. It was the beginning of a unique endeavour that specialised in photographic portraiture, works of art and historical monuments, achieving national and international recognition. With the help of stereomicroscopy technology from Leica Microsystems Alinari is able to preserve the cultural heritage – our memory – for the future generations of professional restorers.

graphy (MNAF) is currently located in the fifteenth-century building known as 'delle Leopoldine'. The importance of this museum is also illustrated by its collection of cameras, advertisements, paper documents, frames and all those objects connected to the photograph which can be considered an integral part of its history. Another 'vital' sector of the museum is the library specialising in the history of photography, with over 20,000 books and journals. The various exhibitions and projects focus on the educational aspect making the collections accessible to a heterogeneous public. One of the primary aims of the MNAF is to create a network of scientific and artistic institutions on a regional, national and international level.

Photographic restoration laboratory

Our restoration laboratory pursues conservation treatment and restoration from the great public archives deposited in museums, libraries, institutes and academies to materials belonging to the archives of industries and firms as well as private individuals. The laboratory is available for consultation and advisory services and various types of conservation treatment.

The Alinari laboratory engages in conservation treatment of many types of materials from the oldest daguerreotypes to calotypes, photographic prints, rare negatives on paper, collodion and silver glass-plate, up to the most recent colour proofs and negatives. We use the latest generation of Leica Microsystems' stereomicroscopes, Leica M205 C with FusionOptics™, video and 3D analysis for acquiring, storing, annotating and displaying high quality images of our heritage which needs restoration. Thanks to the fact that the microscope has an integrated digital camera, we can work using a large high definition flat screen instead of looking through the bin-

The name of Alinari guarantees more than 150 years of experience and state of the art professional technology. Today there are over 2,750,000 b/w and colour nega-

tives in various collections, from plates to colour photos, and over 900,000 vintage prints, including salted paper, albumen, bromide prints, calotype negatives, daguerreotypes, etc., preserved in the collection of 6,000 original albums. These are works by the greatest nineteenth and twentieth century photographers, both Italian and non-Italian, but also by many other less-known professional and amateur photographers. In 2001 the digital archive was inaugurated that continues to grow with images that can be viewed on line. Today there are over 450,000 pictures available on the web (www.alinari.it).

Alinari museum and library

The collection of the Fratelli Alinari Museum of the History of Photography was established in 1985 and completed with a gallery in 1997 in Palazzo Rucellai on Via della Vigna Nuova and now in Santa Maria Novella. The Alinari National Museum of Photo-



Fig. 1: The 150 years of Alinari's activity were celebrated with a special national stamp.



Photos: Alinari Archives



ocular tube of the microscope, thus allowing team collaboration.

In collaboration with the state institute for art restoration in Florence and the Italian Ministry of Culture, Alinari holds nine professional courses dedicated to the restoration of photographic materials. The target audience are professional restorers, archivists, historians and researchers who already have a good background in these topics. The courses include theoretical

and practical experiments using the Leica M205 C. The microscopic analysis supports the recognition of the original material, the analysis of the conservation status and effects of different methods of restoration.

The courses run by Alinari in collaboration with companies, universities and institutions offer a unique opportunity for teaching and providing continuous upgrades of knowledge to professionals on how to preserve the cultural heritage: photographic degradation is an intrinsic process due to the nature of photography. In fact, it is generated by a chemical and physical alteration of the light on the photosensitive substances. The restorer and conservation managers aim at slowing down this process, where possible, by operating on the micro ambience (conservation cases and boxes) and on the macro ambience (archive rooms and thermo-hydrometrical parameter management: humidity, lighting, quality of the air, temperature, etc.). After appropriate analysis and the recognition of the photographic process, the restorer can execute direct restoration of the photography.

Our professional courses take advantage of the digital management of the microscope: we project the microscope view through the control panel of the microscope, we provide live micro-navigation and 3D views of the degradations. The researcher and the restorer can annotate the pictures using a wide range of tools for measurement and reporting. Video sequences are executed to see and evaluate how some chemical agents react on the paper or on other photographic surfaces. With the multi-point focus we obtain images which could not be realised until now: better quality and more information on the object under analysis.

Alinari is going to set up a lot of new research projects to respond to the needs and scenarios provided by the restoration laboratory while using microscope techniques.

Externally offered services

Alinari offers access to its collection and laboratory for external researchers and companies for collaborative research activities, general knowledge and expertise. Our services are also offered to government bodies for analysis and reporting about photography authentication, courses/workshops and publications for safeguarding photographic collections, such as ANAI (Associazione Nazionale Archivistica Italiana), and the Ministry for Cultural Heritage and Activities.

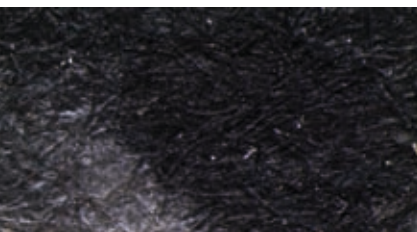
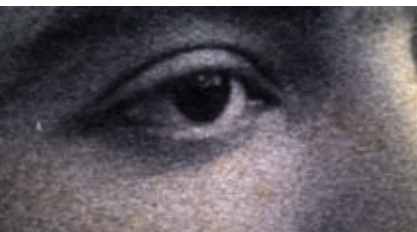


Fig. 2: Restoring laboratory using microscopy techniques



Stereomicroscopy in photo restoration at Alinari's

- Recognition of the photography (Daguerreotype, Albumin, etc.)
- Diagnostics of the preservation status (the restorer detects, analyses and reports through a protocol form about all possible physical and chemical degradations: scratches, abrasions, craquelures, fading, mould, etc.)
- Verifying the restoration workflow
- Monitoring the preservation status
- Restoration and preservation of the originals
- Analysis of the original supports (glass, paper, daguerreotype, collotype, etc.)
- Training for internal and external experts: cataloguers, museum management
- Reporting of biological/physical/chemical alteration of the picture and its support
- Implementation of a data structure for monitoring large collections
- Collecting data and populating a Ground Truth as input to R&D
- Release of guidebooks, reference tables and chart flows

Contact

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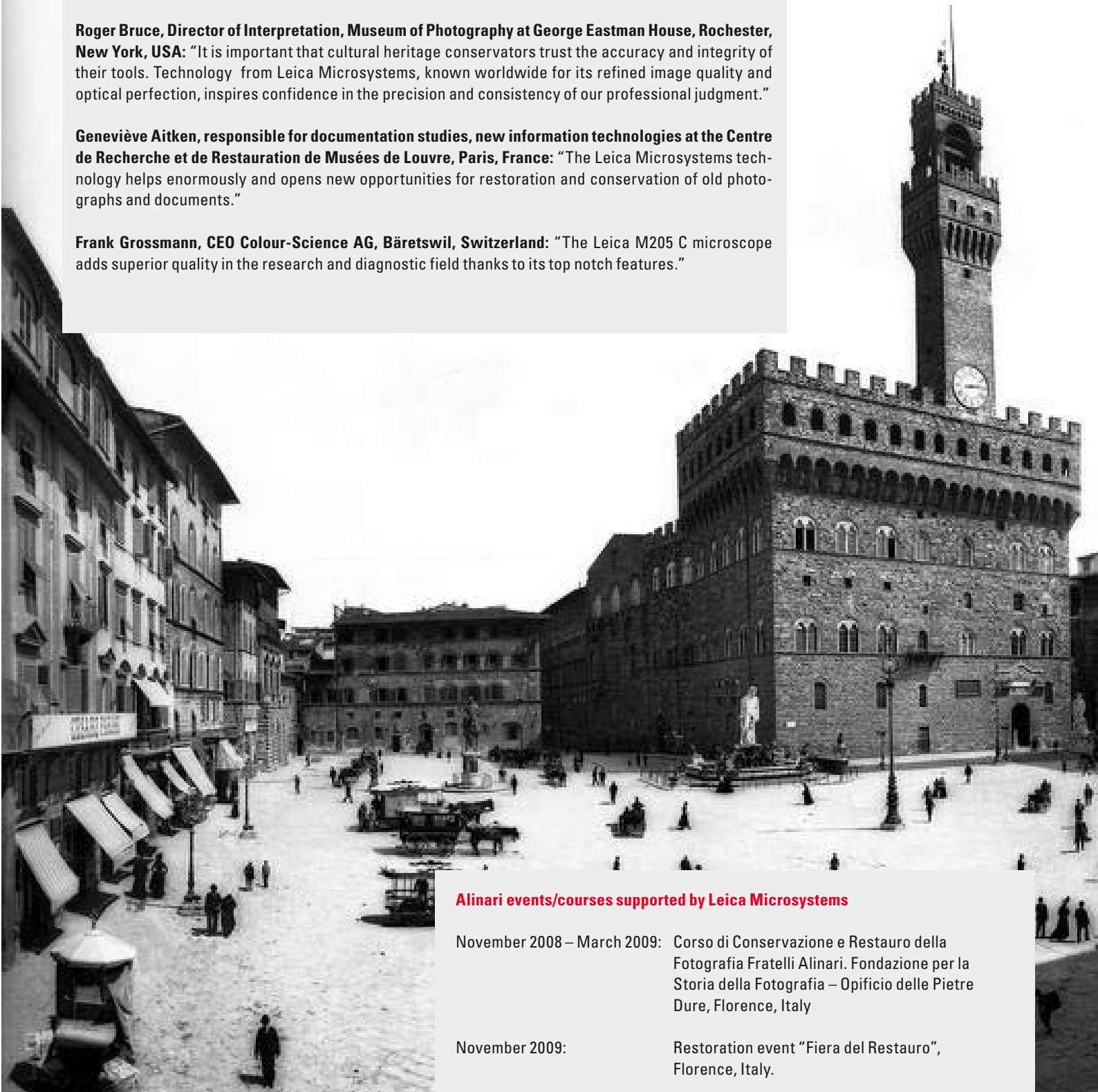
Voices of Alinari's customers

Dr. Hans Petschar, Director Picture Archives Austrian National Library: "It is amazing to see how the work of the restorer can be improved by this technology: you can analyse, document, report and reduce the effort whilst improving the quality of the results."

Roger Bruce, Director of Interpretation, Museum of Photography at George Eastman House, Rochester, New York, USA: "It is important that cultural heritage conservators trust the accuracy and integrity of their tools. Technology from Leica Microsystems, known worldwide for its refined image quality and optical perfection, inspires confidence in the precision and consistency of our professional judgment."

Geneviève Aitken, responsible for documentation studies, new information technologies at the Centre de Recherche et de Restauration de Musées de Louvre, Paris, France: "The Leica Microsystems technology helps enormously and opens new opportunities for restoration and conservation of old photographs and documents."

Frank Grossmann, CEO Colour-Science AG, Bäretswil, Switzerland: "The Leica M205 C microscope adds superior quality in the research and diagnostic field thanks to its top notch features."

**Alinari events/courses supported by Leica Microsystems**

November 2008 – March 2009: Corso di Conservazione e Restauro della Fotografia Fratelli Alinari. Fondazione per la Storia della Fotografia – Opificio delle Pietre Dure, Florence, Italy

November 2009: Restoration event "Fiera del Restauro", Florence, Italy.

The First Dual Core Microscope for Confocal and Interferometry Profiling

Combined Precision for Non-Contact Surface Metrology

Dr. Roger Artigas, Sensofar-Tech S.L.

In recent years, interferometers and optical imaging profilers based on confocal technology have been competing fiercely to conquer the non-contact surface metrology market. They are both capable of accurately and reliably measuring surface topographies on a millimetre to nanometre scale. Today, Leica Microsystems and Sensofar present a new complete solution able to outperform all existing systems due to its unique combination of techniques. The DCM 3D is the first dual core 3D measuring microscope which combines both confocal and interferometry techniques. In addition to its compact and robust design, the DCM 3D is a complete tool that is ideal for obtaining a super fast, non-invasive assessment of the micro- and nanogeometry of technical surfaces, in multiple configurations: From R&D and quality inspection laboratories to robotic driven systems during on-line process controls, the new DCM 3D is able to serve a wide range of applications where high-speed and high resolution measurements down to 0.1 nm are needed.

Unique combination

The dual core 3D measuring microscope DCM 3D offers a unique combination of confocal and interferometry in a single sensor head. The core technology is based on a fast reaction microdisplay placed in the position of the field diaphragm. Bright field, interferometric and confocal images can be generated by the control of the microdisplay. The non-moving part concept, the confocal microdisplay (MD), two light sources and two cameras (one colour and one monochromatic) achieve high accuracy 3D measurements and unlimited depth of focus.

Confocal MD technology allows measurements of smooth to rough surfaces, of topographical differences ranging from 1 nm to several mm, and up to 70 degrees of local slope. In comparison to Laser Scan based systems or Spinning Disc, MD confocal technology needs no moving mechanical parts, increasing both image stability at high magnifications and light efficiency, and enhancing reliability and flexibility. Along with a LED based light source, MD technology prolongs instrument lifetime, reducing servicing and avoiding the cost of expensive spare parts.

Surface measurements are achieved in seconds. The system is easy to use. Just place your sample under the microscope, focus and click "Acquire". It only takes a few seconds (typically less than 5) to get a 3D view of the surface comparable to those acquired with a scanning electron microscope, in a fraction of the time.



Fig. 1: The DCM 3D

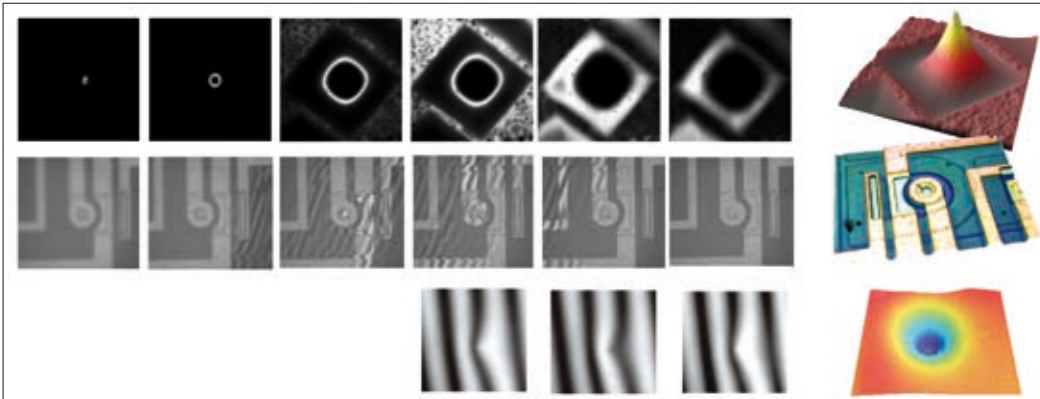


Fig. 2: Confocal, VSI and PSI optical profilometry

3D profiling and unlimited depth of field

As an example, the paint adhesion ability on a steel surface is characterised. After polishing, the steel was too smooth to allow good adhesion of an enamel-based composition. To increase the adhesion the steel is processed with an acid attack to create micro-valleys. This enables the paint to penetrate further into the surface, increasing the effective contact area and improving adhesion to the upper layers. As a result the paint is fixed hard. If the micro-valleys are too deep, however, the upper layer of the paint tends to follow the shape of the valleys in the underlying steel surface. On the other hand, if the microstructures are not deep enough, there is no adhesion effect.

With the DCM 3D it is possible to inspect the surface and obtain suitable quality parameters to decide if the surface treatment is adequate or not. Already after placing the surface under the microscope, it is easy to get a good idea of the depth of the micro-valleys. The real-time confocal image allows you to focus on top of the surface, move the focus down to the valleys and take a direct reading of the depth. After clicking the "Acquire" button to get a 3D view, the confocal scan is so fast that you don't get time to follow what is happening. A pseudocolour display of the topography is shown on the screen with clear presentation of the micro-valleys. Figures 3 and 4 show the result of such a measurement. In order to get a quantitative analysis of the micro-valleys, the 3D analysis software included with the system, called SensoMAP, was used.

The software automatically segments the regions of the upper structures and the regions of the valleys. The volume distribution of the segmented regions (Fig. 5) was a suitable indicator for this purpose. Another useful parameter is Sdr (hybrid parameter, ISO 25178). This parameter represents the proportion of the 3D surface that has been formed to the vertical

projection of this area. Thus, a plane surface has a ratio of 1:1, while a surface with valleys increases the 3D area and thus this value. In our case we concluded that the optimum value should be 1:1.33, that is, a 33% increase of effective area.

Outperforming any profiling technology

A unique benefit of the DCM 3D is the fact that it incorporates two CCD cameras. One is a colour camera used for bright field inspection, while a high quality monochromatic CCD is used as a metrological detector. During the 3D measurement of an area, a high resolution and high contrast confocal image and an infinite focus colour image are acquired simultaneously. The analysis software allows 3D imaging of the surface in different colour modes such as pseudocolour display of the topography, confocal stack, infinite focus colour image and high resolution confocal luminance with the chrominance signal of the colour camera.

One of the main confocal benefits for 3D profiling is its flexibility to use microscope objectives originally designed for bright field microscopy. This means that the ideal optics are generally available to match the desired application, such as objectives with long free working distances for large topography variations within the sample or for sample geometries that would collide with conventional objectives, objectives with an adjustable collar ring designed to focus through coverslips, objectives for LCD inspection.

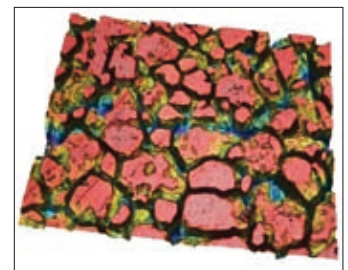


Fig. 4: Three dimensional view of the surface under inspection

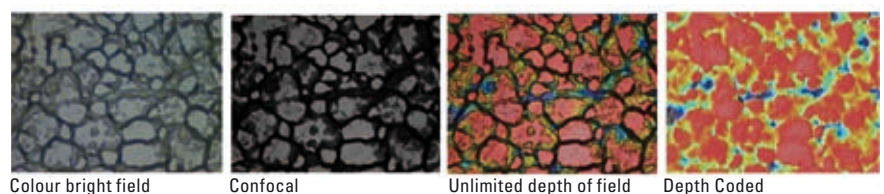
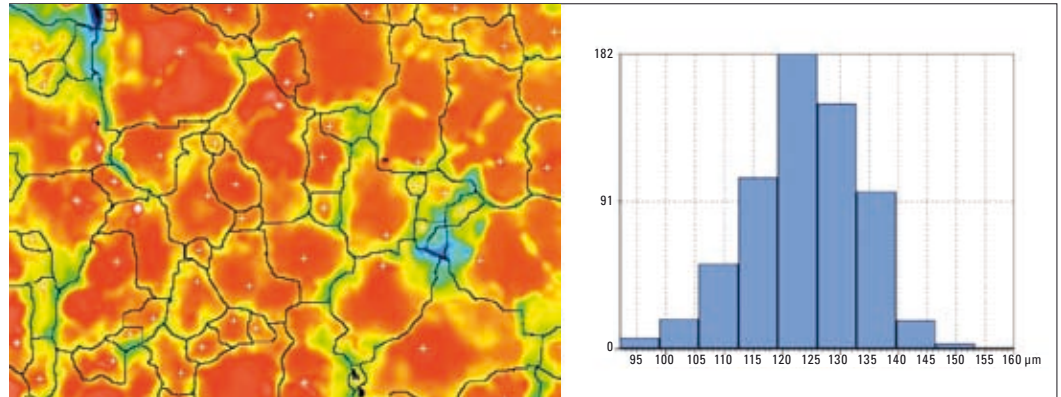


Fig. 3: Microscope modes

Fig. 5: Left: microvalley segmentation, right: volume distribution of the microfragmentations



tion, and objectives for water immersion. Nevertheless, the numerical aperture of the objective limits the depth of focus and thus the height resolution. Low magnification objectives have lower NAs and confocal 3D measurements tend to be noisier. The DCM 3D achieves the highest measurable surface height range by its unique combination of confocal and interferometry technology.

In contrast to confocal technology, depth discrimination of phase shift interferometry (PSI) and vertical shift interferometry (VSI) does not depend on the objective's NA but on the light source properties. Despite PSI height resolution being down to 0.1 nm, the maximum measurable height is limited to 250 nm by optical laws. Nevertheless, the confocal + interferometry combination allows measurements from 0.1 nm to several mm. Figure 8 shows the result of measuring a 10 nm step height standard with PSI technology, a height resolution not possible with conventional confocal technology.

Leica interferometry objectives and powerful analysis software

The DCM 3D uses Leica Interferometry Objectives to provide additional benefits to cover customers' needs. The full range of interferometry objectives (5x, 10x, 20x and 50x) can be used for both interferometry techniques PSI and VSI. A unique system of tip-tilting (tilting at right angles to the optical axis) is integrated on each objective, dramatically improving the time and the ease of alignment between the surface of the sample and the optical axis in order to obtain interference fringes with the best contrast. In addition each objective is equipped with a dial with four different positions to change the amount of light reaching the sample. It is therefore possible to analyse samples with all kinds of reflectivity, increasing the flexibility of the whole system.

The DCM 3D is driven by field-proven SensoSCAN software. This package controls the whole system and also allows several 2D/3D measurements. In addition, the system is fully compatible with SensoMAP, one of the most advanced 3D analysis packages for microscopic analysis of surfaces. When automatic 2D analysis is needed, the system is also compatible with the well known Leica Imaging Analysis Systems Leica Application Suite, Leica QWin and Leica Material Workstation.

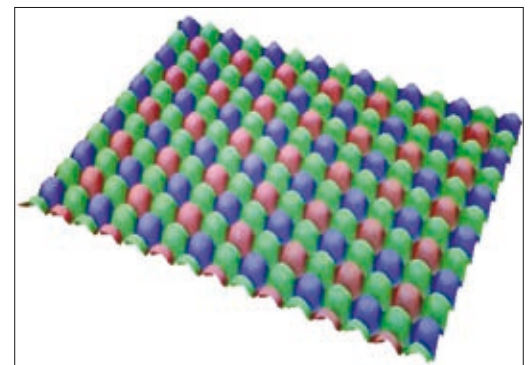


Fig. 6: 3D view of the bayer filter on the microlens array of a CCD

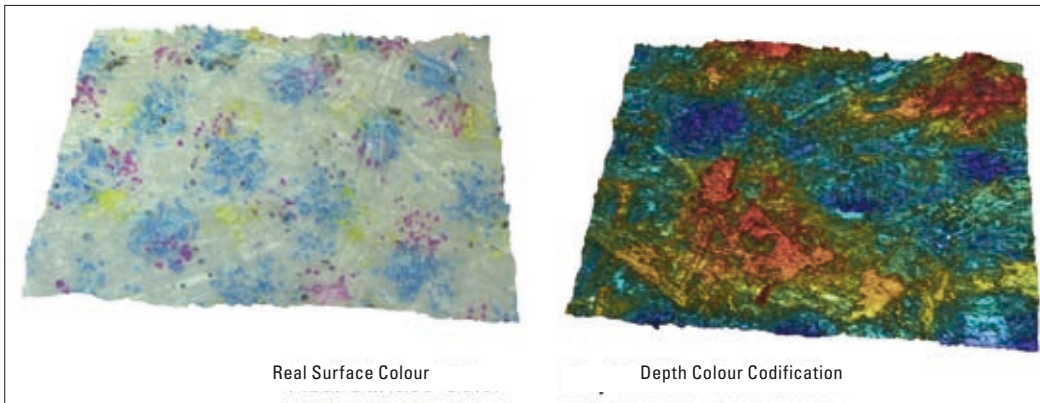


Fig. 7: Paper portion after ink-jet printing. Left: 3D view with bright field colour Information, right: the same 3D view with pseudocolour display of topography.

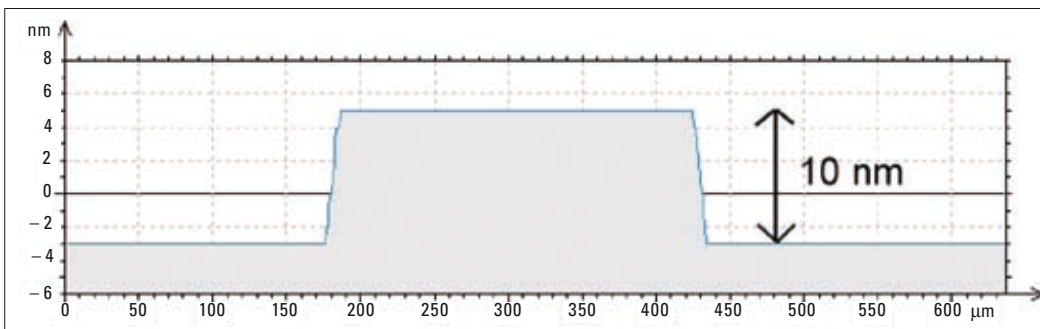


Fig. 8: Step Height standard of 10 nm measured with PSI technology, a measure not possible with conventional confocal technology.

New team of experts to support users in Europe

Oscar Rodriguez, Sales Manager Iberia for the Industrial Division at Leica Microsystems:

“The DCM 3D is a great example of the Leica Microsystems philosophy where pioneering and team spirit have always been key drivers of innovation. The unique system combines confocal and interferometry technology to cover the broadest imaginable range of 3D measurement applications. This innovative technology and the outstanding Leica optics make DCM 3D the perfect choice for industrial 3D imaging and measurement applications.

However, a technology would be worthless without the people who use and continuously develop it. That is why we have assembled a team of application specialists which will provide technical support to users of the new DCM 3D system in Europe. Our team is committed to action before you even begin using the system. For instance, our engineers will analyse material specimens and work with you to specify the main applications of your DCM 3D so the system is optimally configured for your needs. You can always rely on our application specialists to help you solve any problems you have. Working in close co-operation with our development engineers, they will take your ideas and requirements and turn them into new and innovative solutions for future applications in an ongoing process of improvement.”

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Magnetic Fields Optimise Metal Alloys

Research for the Optimal Structure

Dr. Sven Eckert, Research Institute of Dresden-Rossendorf and Anja Schué, Leica Microsystems

To see how liquids can be made to flow, without being directly heated or touched, you only have to watch a raw egg explode in a microwave oven. Electromagnetic forces can even melt metal at hotter than 1000 °C. In the Magnetohydrodynamics study group at the Research Centre Dresden-Rossendorf (FZD) these complex interactions between electrically conductive liquids and magnetic fields are used to control the flow and solidification processes of liquid metal alloys. The aim is to create optimised production processes for foundries. To analyse the microstructure of the metal, the scientists use an automated system consisting of a high-end microscope and Power Mosaic image recording software that scans large surfaces of the samples in high-resolution single frames and combines these as a precise overall image for quantitative analysis.

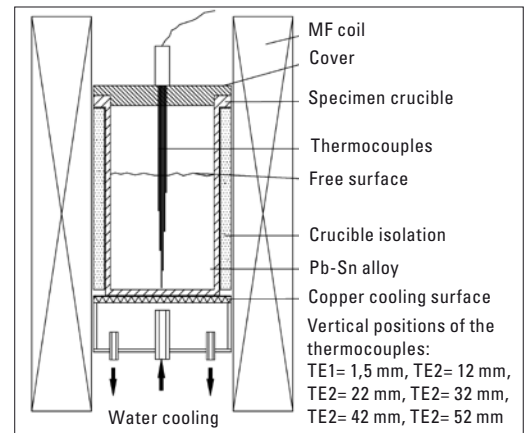


Fig. 1: Diagram of the experiment set-up

The automobile and aerospace industries in particular use components made of special alloys which have to satisfy constantly growing quality specifications. There is a demand for thinner, i.e. lighter castings. Sometimes they have to be more complex or larger at the same time and still have to withstand increasing loads. The stability and load bearing capacity of an alloy mainly depends on its microstructure. Magnetic field flow during the solidification of metal alloys determines the transport of heat and material in the melt and thus the nucleation and grain growth. An ideal, i.e. uniform fine-grain microstructure therefore requires controlled solidification of the casting.

The German Community of Research Scientists (DFG) has set up a collaborative research centre called "Electromagnetic Flow Control in Metallurgy, Crystal Growth and Electrochemistry" at the Technical University of Dresden, the Research Centre in Dresden-Rossendorf, the Leibniz Institute of Solid State and Material Research in Dresden and the TU Bergakademie Freiberg to study specially tailored magnetic fields for optimised technologies in material processing. The application potential is tremendous. Nearly all industrial metals are obtained from metal melts. The advantages of electromagnetic

stirring in terms of controllability and absence of contact are also being utilised here to research the influence of flow structures on the solidification process of metal alloys.

Optimal non-contact stirring

The scientists at the FZD are conducting a sub-project together with the TU Dresden in which they perform solidification experiments using lead-tin and aluminium-silicon alloys under the influence of rotating magnetic fields (RMF) (Fig. 1 shows a diagram of the apparatus). The aim is to obtain materials with a fine-grained isotropic structure with almost spherical crystals, also called globulites. Normally, the morphology of many alloys is dominated by columnar dendrites. As materials that solidify in the form of globulites exhibit significantly better mechanical characteristics, the growth of dendrites can be prevented by means of magnetically driven flows in the melt bath. On the basis of already well-investigated RMF flows, the scientists at the FZD examined the complex physical phenomena during the controlled solidification process to be able to elaborate an optimal stirring strategy for foundry applications [4-6].

Detailed insights into the structure of RMF-induced flow during solidification are given by numerical simulations carried out in a sub-project at the Institute of Aerospace Engineering of the TU Dresden. The basic findings obtained from the analysis of the flow structures during the solidification process and their influence on the heat and mass transfer in the melt will be directly used in another sub-project at the Foundry Institute of the TU Bergakademie Freiberg and transferred to real castings for aluminium and magnesium alloys.

Modulated magnetic fields

The experiments showed that, given constant cooling conditions, the proportion of the globulitic structure volume depends directly on the type and intensity of the electromagnetically driven flow and can be controlled by a defined setting of the magnetic field parameters. For instance, a distinct grain refinement was detected in the microstructure after electromagnetic stirring (Fig. 2 and 3). At the same time, however, undesirable flow-specific segregations were observed. The Dresden scientists are therefore looking for a specific flow pattern that leads to a fine-grained globulitic structure, but not to any segregation of the phase components.

Results from the numerical simulations show that a controlled modulation of the magnetic field amplitude may generate a suitable flow pattern that significantly reduces the degree of segregation. This was taken as the basis for developing concepts for optimising the time functions for the magnetic field parameters amplitude and frequency which are examined in the solidification experiments. This approach has already brought the first clear success [1, 2].

To obtain a better understanding of correlations between the flow field ahead of the solidification front and the features of the solidification structure, the ultrasound Doppler technique was further developed at the FZD for applications in metal melts. Using this technique, flow speeds can be measured during solidification in the liquid phase for the first time [7].

Quantitative analysis of microstructures

Macroscopic examination of solidified metal cylinders already shows distinct differences caused by the influence of RMF, or how columnar morphology can be changed into globulitic morphology by temporal or spatial variation of the magnetic field (Fig. 4). Microscopic analysis of cross- and longitudi-

nal sections of the 5 cm thick and 6 cm tall sample cylinders enables quantitative analysis of grain size, phase distribution and, in particular, the proportional volume of globulitic structure (Fig. 5). To obtain a high-resolution image of the entire surface of the sample, the Rossendorf scientists use the high performance image recording software Leica LAS Power Mosaic combined with a Leica DM6000 M automated research microscope (Fig. 6). The polished metal sections are automatically scanned at a rate of about 400 frames per minute and a complete image is produced at the full camera resolution (Fig. 7).

The system generates a mosaic of single images at high speed, high accuracy and focusing in manageable data formats. Special advantages of the product from Leica Microsystems: the optimised offset of the image overlap of 16 pixels between the individual images and the autocalibration function directly at the sample to compensate for the finest inaccuracies of stage movement and optics. The individual image size and the compensation of the camera rotation are automatically set by the system. The focus positions can be interpolated over a random number of reference points depending on the surface topography of the sample. The precise control of the microscope stage is crucial for the entire scan and the image recording speed. A fast digital camera triggered via the stage records the images as soon as the calculated position has been reached, without the stage having to stop. If required, a 3D reconstruction over various focal planes can be carried out using a special xyz control board. In this case, however, several images have to be recorded per image field, which slows down the recording speed.

“Compared to the days when we had to compose the single images by hand, the automated LAS Power Mosaic Software from Leica Microsystems saves us a lot of time and effort. We are now able to obtain quick and efficient quantitative analysis over the whole cross section of the sample,” emphasises Dr. Sven Eckert from the FZD. “Apart from this, we have to document and archive all experiment data at the FZD. Here too, the software provides far easier work routines than the ones we did before. We can manage nearly all the main analysis of the metal microstructure with light microscopic techniques. Further quantification of the results with an electron microscope is only necessary for special findings.”

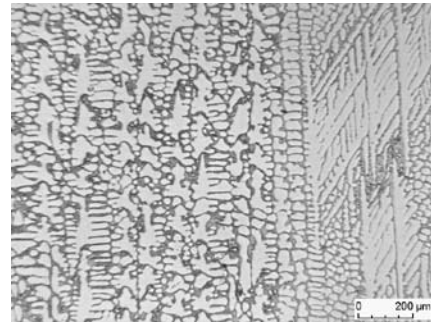


Fig. 2: Light microscope image of an Sn-15M.%Pb alloy directionally solidified without a magnetic field

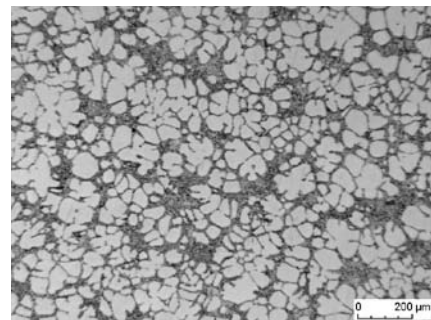


Fig. 3: Light microscope image of an Sn-15M.%Pb alloy directionally solidified under the influence of a rotating magnetic field

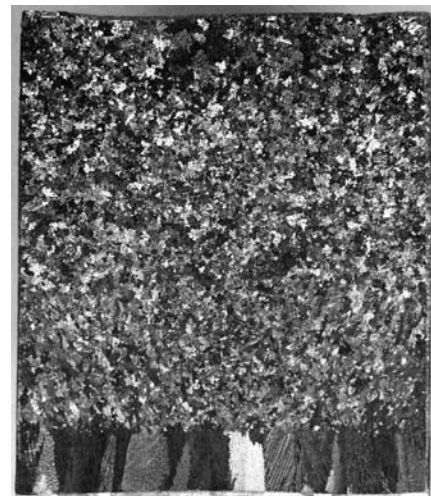


Fig. 4: Photograph of a directionally solidified Al-7M.%Si alloy: Solidification in the lower area without a magnetic field leads to columnar growth. Switching on a temporally modulated magnetic field leads to globulitic grain growth in the upper part of the sample.

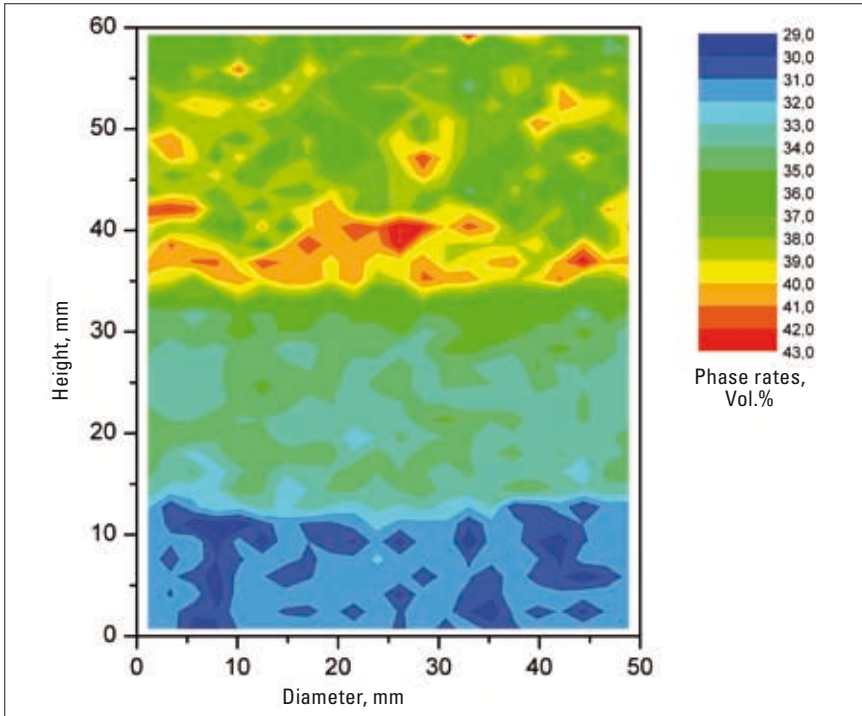


Fig. 5: Proportion of volume of the eutectic phase in the longitudinal section of an Al-7M.%Si sample. A temporally modulated magnetic field was switched on during solidification.



Fig. 7: Photograph of the longitudinal section of an Sn-38M.%Pb alloy. A temporally modulated magnetic field was switched on during solidification.



Fig. 6: The automated system consisting of a high-end microscope Leica DM6000 M and Leica LAS Power Mosaic image recording software scans large surfaces of the samples in high-resolution single frames and combines these as a precise overall image for quantitative analysis.

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This article appeared in: *Quality Engineering*, 10/2008, Konradin Verlag, Ernst-Mey-Str. 8, D-70771 Leinfelden-Echterdingen, Germany, www.qe-online.de

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Keyword: Digital resolution

Beware of Pixel Mania

Urs Schmid, Leica Microsystems

Photokina – Every two years the latest digital cameras are presented at the biggest international exhibition of photography and imaging, as manufacturers race to outdo each other with ever-increasing numbers of megapixels. The world record for professional medium format digital cameras has now surpassed 60 megapixels per shot using a very large and expensive sensor with a resolution of about 9000 x 6700 pixels. Each time you capture such an image you get about 180 MB of uncompressed data and even more if you switch to 16-bit per colour for full dynamic range.

The choice of camera type depends on your application

Digital photography has been in the clutches of pixel mania for years now – and there is no end in sight. In microscopic applications, however, the camera with the most pixels is not necessarily the best one. The application and optical power of the microscope are the factors determining which camera will ultimately produce the best imaging results. The key criterion for microscopic resolution is the numerical aperture (NA), i.e. the light-gathering power of an optical system (refer to reSOLUTION, 01/2008).

Ten-metre thick microscopes?

The light-gathering power of cameras or telescopes can be increased by using larger lenses with more diameter. The world record is held by the new 10.4 metre diameter mirror at the astronomy observatory in Las Palmas, Spain. However, this is not possible with microscopic lenses. You can increase the light gathering power effectively by interposing a medium with a high refraction index between lens and specimen, but in general the NA of a good dry lens is limited to about 1.0 and a good immersion oil lens to about 1.45. The NA for stereo microscopes



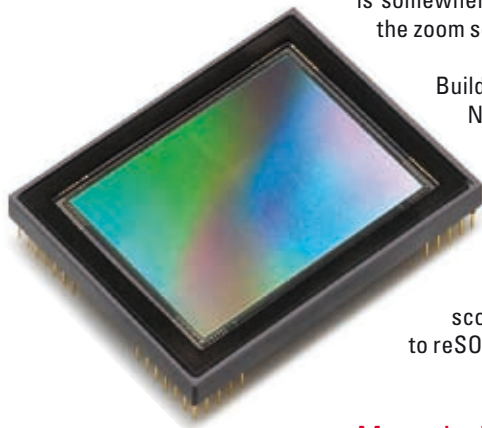


Abb. 1: CCD-Sensor for digital microscope cameras

is somewhere between 0.01 and 0.2 depending on the zoom setting.

Building stereo objectives with even higher NA is extremely difficult as you have to stay within the 24 mm stereo base to avoid altering the geometry of the stereoscopic system. With innovative FusionOptics™, however, Leica Microsystems succeeded in setting a new world record for stereoscopic resolution and depth of field (refer to reSOLUTION, 01/2008).

Megapixels versus magnification

Applying the formula of $3000 \times \text{NA}$ you can easily calculate how many pixels are actually available at the sensor of the camera taking into account the actual magnification and the sensor size. At low magnification, the microscope is usually able to deliver more details to the camera than it can capture. At high magnification however, it is the optical system that limits the amount of detail that a camera can capture. At 1x magnification the instrument delivers about 14.3 megapixels of information to the camera, while at 16x this figure drops to 2.6 megapixels.

How do you explain this apparently inverse effect? It has to do with the limited field of view. At high magnification or zoom settings, the field of view is relatively small. Looking at the round and bright circle on your specimen when using coaxial illumination clearly indicates that the higher you magnify, the

smaller the bright spot becomes. You can resolve more details when you zoom into a detail or switch to a lens with higher NA.

Enhancing your camera

If you work mostly at very high magnifications, the optical system is limited to about 3-5 megapixels that can be transferred to the sensor of a camera. Setting the camera to a high resolution of, say, 12 megapixels would produce a larger image, but you would not gain any additional information. If you use the microscope in low magnification on the other hand, then you definitely need a high resolution digital camera to capture all the details that your microscope can deliver – even such details in your specimen that you cannot see with the naked eye at that magnification.



Fig. 2: Resolving power at low/high magnification

New Routine Stereomicroscopes

For Different Challenges Every Day

The high-quality routine stereomicroscopes Leica M50 and M80 complete the proven M-Series range from Leica Microsystems. The optical brilliance, the wide range of accessories, and the ergonomic solutions make them the ideal microscopes for quality assurance and many industrial applications. The Leica M50 includes precisely reproducible magnification levels from 6.3x to 40x for repeated examinations, measurements, drawing or photography of objects under absolutely identical conditions. The five easily selectable positions can be set without remov-

ing the eyes from the eyepieces. The Leica M80 stereomicroscope with the 8:1 zoom and switchable ratchet steps can be used for a wide range of routine applications. The large working distance and the brilliant imaging power show the finest details of the samples without losing the overview of large workpieces. Both microscopes can be equipped with a wide range of accessories – different illumination types, objectives or bases – for every kind of application.

The Leica M50

- Magnification range 6.3 – 40x
- Five defined, locking magnification levels
- High depth of field for observing objects over an extended area

The Leica M80

- Zoom range 7.5 – 60x
- Eight switchable, locking zoom levels
- Optics with excellent contrast for a detailed view of the specimen

The new stereomicroscopes

- Modular product range for optimum adaptation of the microscope for the application
- Parfocally matched optical system: the sharpness remains constant when the magnification is adjusted
- Field number 23 for an even greater overview
- 76 mm standard interface for quick and simple integration
- Wide range of achromatic and planachromatic objectives
 - Ergonomic design for individual adaption to the user
 - ESD design prevents damage caused by static discharge.
- Focusing column with integrated cable channel keeps the workplace tidy.



Fig. 1: Leica M50 with small swing arm stand (left), Leica M80 with incident light base (right)



Fig. 2: Leica M80 with XL universal base and XL extension

Different illuminations

Only the correct illumination exploits the full power of a microscope and gives the maximum possible information from the sample. That's why Leica Microsystems offers various types of illumination – to suit every application.

The unique Leica LED3000 NVI™ is optimised for routine stereomicroscopy. This illumination is the ideal solution for viewing holes, indentations or gun barrels. The Leica LED5000 range is another central component in the Leica stereomicroscope system. The most recent addition to this series is a fully integrated coaxial illumination. Two integrated high-power LEDs ensure excellent illumination while the data exchange for reading and controlling the settings is conducted over one single cable.

Clever ergonomics

When the viewing height of the microscope is matched with the physical height of the user, a few millimetres are crucial. A tube with variable viewing heights such as the new ergobinocular tube solves this problem with a few simple twists of the wrist. To avoid tension in the neck and back muscles while seated at the microscope all control elements of Leica stereomicroscopes are arranged for the greatest possible comfort of the user.

Our Thank-you for Your Feedback!

Dear Reader,

Which article in this edition of reSOLUTION did you like best? Which topic would you like to learn more about in forthcoming editions? As a reward for your feedback we will send you a high-quality illustrated book published by Alinari about the history of writing and printing. It charts the evolution of writing and printing from the simplest forms of human communication through Gutenberg to the triumphant success of printed matter and modern digital printing.



Please post your comments (including your address) by 31st March 2009 to: www.leica-microsystems.com/EU-Materials

Jean Marc Ellens from Leica Microsystems congratulates Franck Herzog, a member of the Quality Assurance department at Liebherr-France SAS, Colmar, who won the cubo design CD radio with MP3 player in reSOLUTION 1/2008.



A History of Writing and Printing From Cave Paintings to Pixel
S. Füssel, R. Leinemann,
J. D. Meyer, N. P. Miller, L. J. Rolly

All-In-One Target Surfacing System for SEM, TEM, and LM

Let the System Do the Job

Robert Ranner, Leica Microsystems

Today's electron microscopy and microstructure analysis, such as energy dispersive X-ray spectroscopy (EDS), wavelength dispersive spectrometry (WDS), Auger, and Electron Backscatter Diffraction (EBSD) require fast and simple methods to reveal internal structures near the surface that signify mechanical deformation or damage. Current preparation techniques are either too slow, lacking in quality or are able to expose only small areas.

The Leica EM TXP, a one-of-a-kind precision instrument for preparing cross sections, unites four machining technologies in one instrument. The all-around instrument from Leica Microsystems saws, mills, grinds, and polishes material specimens for scanning electron microscopy (SEM) and incident light microscopy. For example, quick and accurate pinpoint preparation of microelectronic gold bonding wires in semiconductor chips is possible without the need to transport the specimen between various instruments.

Time-saving and reliable

When material specimen surfaces are prepared for SEM or incident light microscopy in industrial quality control, the specimen usually undergoes multiple processes until the layer or surface to be analysed is precision machined. Whereas previously, specimens had to be prepared using various instruments, all required machining steps – from diamond cutting and milling to polishing – can now be completed on one instrument, the Leica EM TXP. This reduces not only the amount of time required, but also the risk of losing specimen detail.

The automated Leica EM TXP gives the user additional support for quick and reliable preparation. All parameters can be preset for each operating step; the instrument then works fully automatically. Another important labour-saving feature is the integrated stereomicroscope that enables the user to observe the specimen during the entire machining process. There is no longer a need for the laborious process of localising and examining intermediate results using a separate microscope.

Give large surfaces the final touch

In combination with the Leica EM TXP, the Leica EM TIC020 provides extremely fast target sample preparation for scanning electron microscopy. The Leica EM TIC020 is equipped with a triple ion source to enable the preparation of large area cross sections. First the Leica EM TXP is used to



Fig.1: The Leica EM TXP with specimen pivot arm

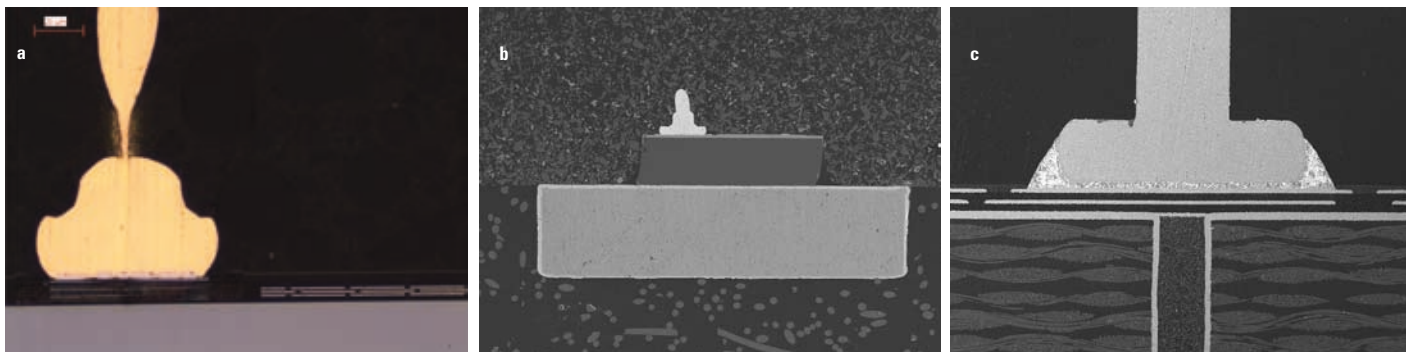


Fig. 2: Prepared with Leica EM TXP; a: cross section gold wire bonding, IC-package, b: cross section SMD LED, c: cross section PCB with connecting pin



Fig. 3: Prepared with Leica EM TIC020: cross section solder ball on Ni/Co pad



Fig. 4: The slope cutting systems Leica EM TIC020 (at the front) and the flexible Target Surfacing System Leica EM TXP (at the back)

mill off a large part of the sample in order to reach the region of interest with utmost precision. Then the final cross section is carried out with the Leica EM TIC020. This process drastically reduces etching time, leading to a significant increase in total sample throughput.

This new technology permits high cutting speeds and deep cuts, while producing smooth surfaces suitable for microstructure analysis. It is possible to achieve cross sections that are millimetres deep and several millimetres wide. Conventional slope cutting systems require sample movement to reduce shadowing/curtaining induced by different sputtering rates for different materials. The triple ion source eliminates this requirement. While the main application lies in the semiconductor field, i.e. metals, ceramics and polymers, with the Leica EM TIC020 practically any material can be prepared.

Events

2008

Worlddidac

October 29 – 31
Basel, Switzerland

EMAF

November 11 – 12
Oporto, Portugal

Prodex

November 18 – 22
Basel, Switzerland

2009

Laborama

March 12 – 13
Brussels, Belgium

austrotec 09

March 12 – 13
Graz, Austria

Congreso Soc. Port. Materiales

April 5 – 8
Lisbon, Portugal

SMT

May 5 – 7
Nürnberg, Germany

Control

May 5 – 8
Sinsheim, Germany

22° Congresso Nazionale dei Trattamenti Termici

May 6 – 8
Salsomaggiore, Italy

Environnement Professionnel Horlogerie-Joaillerie (EPHJ)

May 12 – 15
Lausanne, Switzerland

National Electronics Week

June 16 – 18
London, Great Britain

MesurExpo

October 6 – 8
Paris, France

Rich Mac

October 6 – 9
Milano, Italy

Parts2Clean

October 28 – 30
Stuttgart, Germany

Productronica

November 10 – 13
Munich, Germany

Milipol

November 17 – 20
Paris, France

Imprint

Publisher

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

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Printing Date

November 3, 2008

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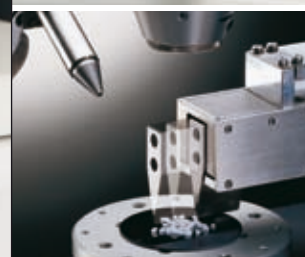
Leica DM750 P – For the Experts of the Future

To ensure that budding geoscientists and materials scientists are well prepared for the tasks ahead of them, Leica Microsystems has developed a microscope specially for use in the area of practical knowledge transfer. Thanks to its outstanding optical power and user-friendly functions, the new Leica DM750 P polarisation microscope is a valuable training tool for students of petrography, crystallography and materials science.

The Leica DM750 P is based on the same optical platform as used by the high-end microscopes of Leica Microsystems. Not only does it have impressive optical power, it is also fully compatible with the entire range of Leica Microsystems microscope accessories. Finely tuned lenses and optics prevent interference of the polarised light by the specimen. Equipped with high-grade components, the new polarisation microscope covers a wide range of applications in geoscience and materials science.



Cover picture: Steel construction on the site of the Saron Refinery in Ravenna, Italy. The original from the 1960s is from the archive of the Villani photo studio, which was established in 1920 in Bologna, Italy. Vittorio Villani, son of the founder, participated in one of the most comprehensive photographic documentations in Italy, started by the Florentine company Alinari in the mid-nineteenth century. The entire Villani Archive with photos from the 1920s to 1980s is today part of the huge Alinari Collection. Fratelli Alinari in Florence has committed itself to photography, its history and modern development, as well as the preservation and restoration of photographic materials and documents for over 150 years. Today Alinari is one of the world's most renowned companies in the field of photography.
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Leica M50 and Leica M80 – For new challenges every day in the lab and in production

To ensure that your products are of the highest quality, you examine your samples down to the smallest detail. Leica Microsystems has developed the Leica M50 and Leica M80 stereomicroscopes especially to lighten your routine inspection workload. Their optical brilliance coupled with a sophisticated range of accessories and ergonomic solutions makes them reliable partners in quality assurance, not to mention a wide range of other routine industrial applications.

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