OLYMPUS
Your Vision, Our Future

Issue 14

ILLUMIN8

The newsletter for microscope users

Welcome

This issue of Illumin8 focuses on the use of microscopes in the engineering and industrial setting. For future issues we would like to know what you want to read about. Moreover, if you are doing any interesting research, or have a great microscopy tip, then send an email to **microscopy@olympus.uk.com** or fill in the reply paid card. You can also use these to request your own copy of 'Illumin8' as well as the handy leaflet and poster series available. We hope you enjoy this issue and don't miss our competition to win an Olympus µ{mju:} 790 SW:

IN THIS ISSUE

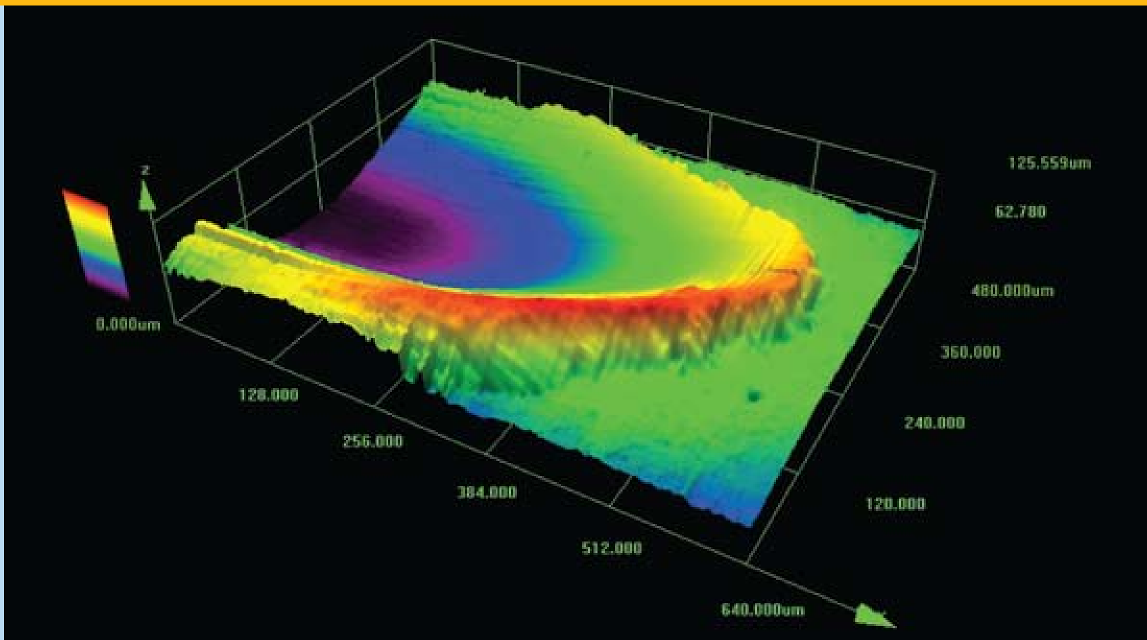

Figure 1 **3D height map of 'pile up' around a scratch as visualised on an Olympus LEXT 3D. (Crown copyright ©2008)**

Confocal Metrology at the NPL

by Louise Brown, PhD

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The National Physical Laboratory (NPL) is the UK's national measurement institute. NPL underpins the national measurement system, ensuring consistency and traceability of measurements throughout the UK. NPL's Advanced Engineered Materials group assess a wide range of materials using sophisticated imaging techniques from optical microscopes through to electron and scanned probe microscopy.

Since its delivery to the NPL in 2007, the Olympus LEXT OLS3100 has been used to assess and measure a wide variety of materials surfaces and artefacts from the nano up to the macro scale. The LEXT is a confocal laser scanning microscope which has helped in the assessment of material's surfaces as it provides 3-D images and precise measurement capabilities. Previously at the NPL, conventional optical and 3-D microscopy, and scanning electron microscopy were used for imaging, but these did not possess the improved resolution and 3-D capability offered by the LEXT. Conventional techniques are still used today but the LEXT enables complementary measurements to be made quickly and easily.

Many of our samples would normally require a scanning electron microscope (SEM) to produce an image of suitable resolution. However, using an SEM requires additional preparation of the sample before an image can be captured. This may include coating the specimen to prevent charging, mounting onto a conductive plate and placing in the SEM. These problems are not an issue using the LEXT as the specimen is placed directly onto the stage with no sample preparation required. Furthermore, as there is no vacuum involved, pump down time is not an issue and larger specimens can be imaged. Importantly, images can be captured as a 3-D data set and measurements taken immediately. Further information from the scan can be obtained at a later date if required from the saved 3-D data set, without the need for re-scanning. The variety of measurements possible includes: depth, width, surface area, volume and roughness. Until now these measurements have not been easy to make.

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The software produces clear images and the true colour contrast allows the user to easily identify areas of the specimen.

The high resolution of the LEXT allows nano-sized objects to be imaged. Figure 2 for example shows graphene flakes (sp2 bonded carbon atoms) on a substrate. These flakes are usually observed using an atomic force microscope (AFM). However, finding these flakes can take time, unlike with the LEXT, which takes literally minutes to identify the required region. These flakes can then be imaged and measurements taken.

The LEXT is extremely useful for determining the hardness of materials by more accurately measuring the impression left by an indentation than can be made using an optical microscope. The indentation is usually made with a Vickers indenter (pyramidal in shape) and the hardness calculated by measuring the diagonals of the indent. For very hard materials, such as WC-Co hardmetals with typical indent diagonals of 100 µm, errors in the region of ± 2 µm can cause a large uncertainty in the calculated hardness value. Measurements made using the LEXT are easier to perform and produce a more accurate value due to the high lateral resolution of the microscope. Indentations often produce pile up around the edges which have not been clear to see until now. Figure 3 shows the pile up around the outside of a typical indentation. Indentation is a plastic deformation process, however, over time there is a small amount of elastic recovery which is clear from the profile of the indentation, see figure 4. One would assume that the sides of the indentation would be straight from the geometry of the indenter, however, it is clear to see that the sides actually 'bow out' due to stress relaxation over time. The 3-D visualisation of the indentation allows a quick assessment of the integrity of the indenter as testing of these materials will cause damage to the tip over time.

Figure 2 ***Graphene flakes as visualised on an Olympus LEXT 3D.***

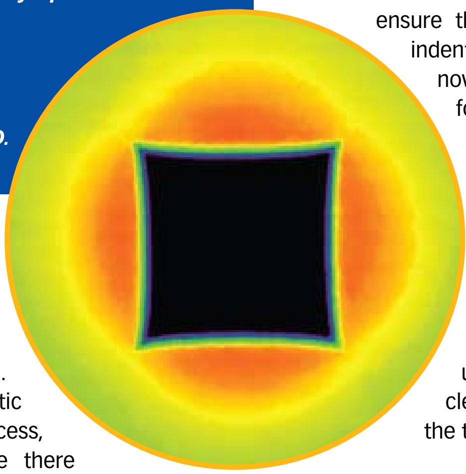

Figure 3 ***Vickers indentation as visualised on an Olympus LEXT 3D.***

Rockwell is another indentation technique used to measure the hardness of materials. This uses a spherical shaped indenter and hardness is determined from the depth of penetration. This technique has been used for assessing the adherence of coatings to substrates. Figure 5 shows a Rockwell indentation made on a coated substrate. The indent is visible in the top right corner and it is clear to see from the 3-D colour height map where the coating has delaminated.

Scratch testing is a technique which allows the mechanical properties of a material to be determined from a carefully controlled scratch under a specific load and distance. The scratch is made using an indenter tip of well defined shape. After measurement of a scratch using the LEXT, it was found that the scratch cross section profile was uneven. Imaging of the indenter using the LEXT showed that part of the tip had sheered (see figure 6) leading to an uneven wear scar.

Scratch testing can also be used for assessing the wear resistance of coatings. The figure on the front page shows a scratch on a coated surface. The 3-D height map shows clearly where there is pile up around the end of the scratch.

Imaging scratches in transparent materials is extremely difficult using conventional optical microscopy due to the non-reflective surface and subsurface reflections. The scratch can be perfectly imaged (see figure 7) and much more detail can be obtained using the LEXT, as this is a confocal microscope and does not suffer the same limitations as conventional light microscopy when examining this type of surface. The profile obtained from the scratch provides detailed information. The volume of the scratch can also be measured.

Nano indentation, like other indentation techniques, is used to assess the mechanical properties of surfaces, coatings and thin films on a small scale. Care has to be taken to ensure that the tip is clean before indentations are made. Until now, an SEM has been used for routine tip inspection. However, the LEXT can be used for quick examination of indenter tips to check the geometry and ensure they are clean. This saves time and also produces a 3-D image of the tip. An example of a tip imaged using the LEXT (figure 8) clearly shows there is dirt at the tip of the indenter.

The LEXT has been used to assess a wide variety of samples and artefacts with good results which has enabled us to extend our imaging and measurement capability. Due to the continually changing demands and new challenges of industry, we are constantly assessing the capability of the LEXT. As there is no sample preparation required, the LEXT enables us to quickly inspect a wide range of materials which would not always be possible to image using alternative techniques.

Figure 4 ***Profile of Vickers indentation as visualised on an Olympus LEXT 3D.***

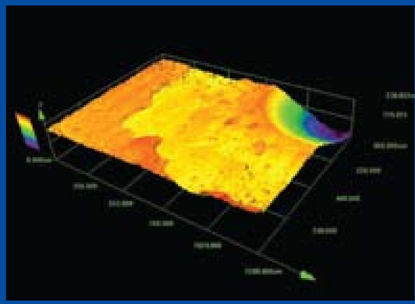

Figure 5 ***3D height map of a Rockwell indentation as visualised on an Olympus LEXT 3D.***

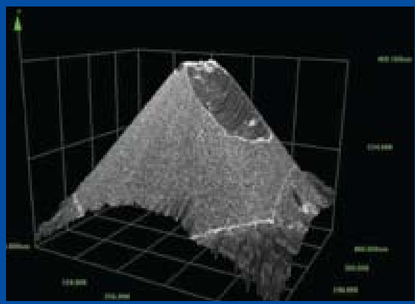

Figure 6 ***Sheared indenter tip as visualised on an Olympus LEXT 3D.***

Figure 7 ***LEXT image of a scratch on glass as visualised on an Olympus LEXT 3D.***

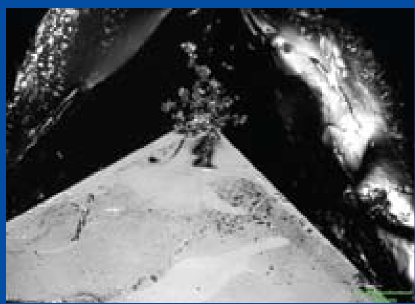

Figure 8 ***Nano indenter tip as visualised on an Olympus LEXT 3D.***

Analysis **This, That and Everything Else**

Olympus SZX7 imaging a gear cog via analysis software

Olympus BX2 microscope with analysis software reporting module

Advances in new imaging technologies and techniques have revolutionised microscopy over the past few decades. Not only have film cameras been largely replaced by digital cameras, but software has been introduced that can enhance images and extract amazing amounts of information. A single image analysis system is now simply not sufficient to satisfy the wide range of emerging multifaceted microscope applications. This is why Olympus offers a great range of dedicated, intuitive tools for image archiving, processing and analysis, for total control, accurate data capture and flexible image processing.

The Olympus analysis software family presents a range of image-processing solutions especially designed for materials inspection applications within a wide range of industries. Each member comprises flexible and high-performance software solutions for digital image acquisition, image processing, analysis and evaluation, image archiving, document management and report generation.

The individual Olympus analysis series of modular software products have a common range of functions. Each successive member is an expansion of its predecessor, making it easy for users to adjust their system to meet new requirement profiles as applications change. The range of products comprises five members-start, work, docu, auto and pro – ranging from simple single workstation solutions for image acquisition and documentation software to complete automatic inspection systems.

Olympus analysis start is a high-performance metallographic image acquisition system with total software control of the camera and microscope, whilst ensuring perfect images and the accurate measurement of particles. Olympus analysis work also offers basic-level functions for all elementary metallographic tasks, with an extended range of interactive measurement functions, as well as structured archiving and professional report generation.

Olympus analysis docu is the most comprehensive documentation member of the analysis family, and offers numerous valuable image acquisition and display functions. Automated image analysis is provided by analysis auto, which additionally offers many functions for particle-orientated image analysis with multifaceted classification options, as well as fully automated stage control.

The highest expansion level of the Olympus analysis product series is analysis pro, which offers professional metallographic image acquisition for the materials sciences. Complex tasks are effortlessly achieved and automatically finished, one after the other. In addition, analysis pro also offers new methods for tracking objects, image filtering, as well as particle analysis.

Comprehensive systems for specialised tasks

Further expanding the analysis family of software solutions by incorporating all necessary hardware components, the analysis inspector series fully automates and solves very specific inspection tasks, such as filter inspector, non-metallic inclusion inspector, cast iron inspector and particle inspector. Each system ensures high accuracy and reproducibility of all measurements, analyses and evaluations conducted. Furthermore, each member of this software solution can be extended via additional application-specific software modules, such as cast iron analysis and grain size analysis.

Conclusion

It has always been important to use the correct microscope to produce the best images. It is now equally essential to choose the right software for imaging and analysis processes. The Olympus analysis family, provides the perfect range of software solutions from basic acquisition through to advanced analysis and reporting

The Straight Way of Tackling Circuits

Olympus LEXT IR

Silicon is amazing. It is the closest element to Carbon in both composition and properties; it is in fact a natural chemical analogue. It is biologically essential too, especially for plants and diatoms. In the form of silica and silicates, silicon forms useful glasses, cements, and ceramics. Compound derivatives of silicon are also widely used in flexible waterproofing solutions or as an additive for lubricants. But, its main use is in the semiconductor industry, enabling the development of highly complex integrated circuits and even Micro-Electro-Mechanical Systems (MEMS).

Packaging technology of semiconductor devices is rapidly advancing e.g. SIP (System in Package), 3-dimensional mounting, and CSP (Chip Scale Package), along with the increase in the need for thinner and smaller electronics

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devices. This makes observation for research or quality control almost impossible, with many components and even circuits packed into a tight space.

The new Olympus LEXT-IR (OLS3000IR) is a confocal laser scanning microscope that uses a 1310 nm laser to literally see through the silicon to the components. Based on the highly successful metrology system - LEXT-3D (OLS31000) – the LEXT-IR is perfect for silicon device inspection, providing fast, efficient and easy-to-use capabilities for ultra-fine subsurface resolution with SEM-like clarity for a wide range of imaging tasks:

Flip chip mounting defect analysis

In flip chip bonding, once mounted the pattern cannot be inspected using visible light. However, the silicon chip is transparent to infrared light and the interior can be observed without destroying the mounted chip. Defect analysis is easily performed by merely placing the device under the LEXT OLS3100IR.

Chip damage analysis

With the LEXT OLS3100IR, device changes during heat and moisture tests can be inspected non-destructively. For example, leakage due to melting and corrosion of copper wiring, peeling of resin parts, etc. can all be clearly observed.

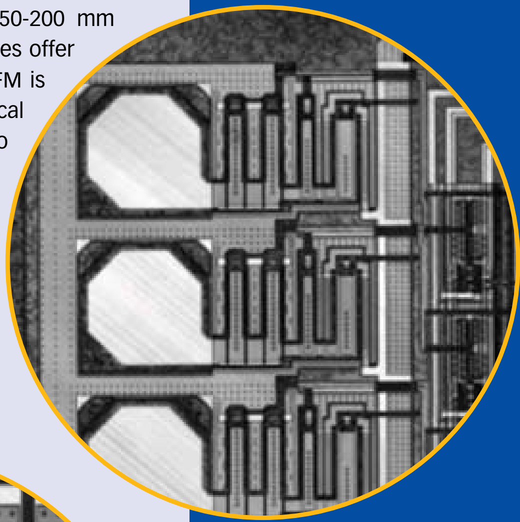
Chip gap measurement

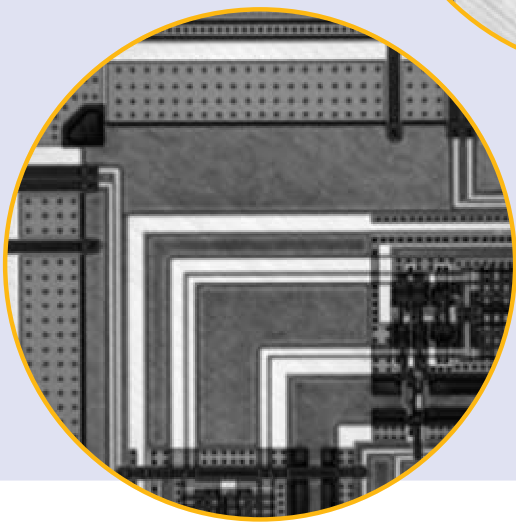
Three-dimensional mounting chip gaps can be measured as the movement of the objective when infrared light is passed through the silicon then focused on the chip and interposer. This method can also be used in the measurement of key features in micro-electromechanial systems (MEMS).

A World leading IR Team

As well as the peerless LEXT OLS3000IR, the Olympus IR microscope system range provides non-destructive inspection capabilities for all silicon-based circuits, whatever the requirements. The inverted MX series is perfect for the observation of 150-200 mm wafers. The upright BX2M microscopes offer transmitted illumination and the BXFM is an equipment oriented modular optical unit enabling it to be integrated into other pieces of equipment, such as production lines for in situ inspection.

To find out more about any of the Olympus IR inspection products or services mentioned, please email **microscopy@olympus.uk.com**





Win the Tough new Olympus μ[mju:] 790 SW **Digital Camera**

The new Olympus μ[mju:] 790 SW takes snowstorms, monsoons, earthquakes, avalanches, tornadoes, rockfalls as well as very good photos. It handles whatever life throws at it, so there's never a need to worry. Despite its tough attributes, the 7.1 Megapixel μ[mju:] 790 SW looks great and doesn't compromise one bit on photographic features. We are giving one away, so to be in with a chance of winning you will need to answer these three questions correctly on the reply paid card and return it to us by the 1st April 2008.

Congratulations to Dr D. J Price, from the University of Plymouth Dept of Biological Sciences for winning the Olympus μ[mju:] 1200 digital camera from the last issue of Illumin8.

Question 1:
Graphene flakes are based on what kind of carbon bonding?

Question 2:
What are the five members of the Olympus analysis software family?

Question 3:
What wavelength is the laser on the Olympus LEXT-IR (OLS3000)?

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