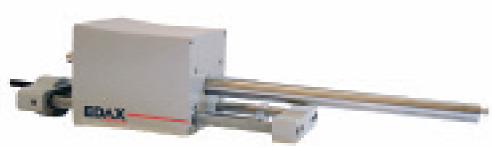
EDAX FOCUS

The Right Silicon Drift Detector for the Right Application

The Silicon Drift Detector (SDD) was introduced a few years ago with the idea that it would quickly replace the Si(Li) EDS detectors. It offered room temperature operation and near theoretical energy resolution, even at count rates over 500,000 cps. Unfortunately, the performance of the initial generations of the SDD chip did not satisfy all of the above claims. The SDDs operated at room temperature, LN_2 was eliminated, and good energy resolutions were achievable. However, the energy resolutions and peak positioning were not stable with varying count rates. Also, low energy performance was very poor, resulting in the uncertain identification of carbon.

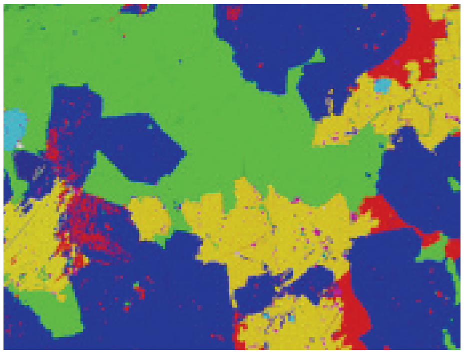


Apollo XV SDD

The performance of today's SDD EDS systems varies, not only from the generation of the chip used in that model, but also from the size of the chip. SDDs are available today in many different sizes, varying from 5mm^2, 10mm^2, 30mm^2, and 40mm^2. They can also be offered with a confusing array of resolutions. Finding the right SDD for the right application has never been tougher.

The EDAX portfolio of silicon drift detectors provides solutions for all X-ray microanalysis applications including accurate qualitative and quantitative analysis, fast and ultra fast X-ray mapping, phase analysis, and complex particle analysis. The Apollo series SDD provides a range of chip size, resolution performance, and light element capabilities that ensure there is an ideal choice for each application.

For applications that require ultra fast X-ray mapping, the Apollo 40, with its unique 40mm^2 SDD chip, provides the best collection efficiency available of any SDD for X-ray microanalysis. Collection efficiency is a key factor for ultra fast X-ray mapping, (as long as the combination of the SEM and sample are capable of generating high count rates). The detector with the best collection efficiency (solid angle) will be able to collect the most counts. The Apollo 40 SDD also provides excellent energy resolution and light element performance, along with collection efficiency. It is the ideal SDD for ultra fast X-ray mapping, as well as other demanding applications such as complex particle analysis.



Apollo 40 SDD X-ray map of granite, collected at 250,000 cps.

In spectral analysis applications energy resolution and low energy performance are important considerations. The ability to resolve line overlaps and generate accurate qualitative and quantitative analysis often depends on good hardware and software working together to improve the results. Deconvolution software and background correction will generate good quantitative data, but good energy resolution provided by the EDS detector is certainly an advantage. The latest SDD chip technology, used in the Apollo XV SDD, offers the user considerable improvements in energy resolution and low energy performance.

Inside This Issue

Vol.6 No.1

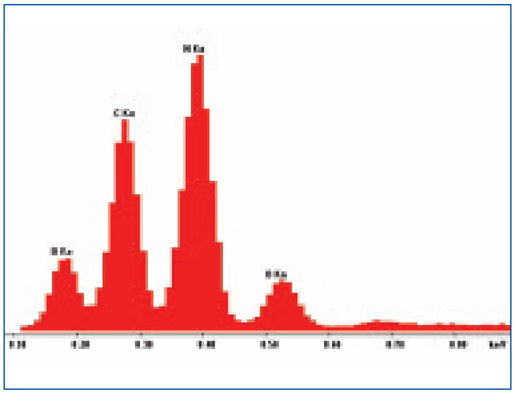
XRF NEWS

The Right Silicon Drift Detector for the Right Application

(Cont'd. from Pg. 1)

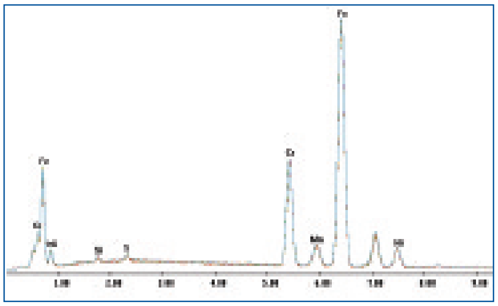
A few years ago the Si(Li) EDS detector was acknowledged as providing the premium low energy performance solution. Today the impressive energy resolutions and low energy performance of the Apollo XV SDD provides a significantly improved performance for many spectral applications. Energy resolutions of <128 eV at Mn Kα provide the platform for the best qualitative and quantitative EDS data. Typical resolutions of 52 eV at C Kα set the new standard for low energy X-ray microanalysis applications. The Apollo XV SDD now replaces the Si(Li) DU as the ideal EDS detector for these spectral applications. The characteristics of the Apollo XV SDD ensure that the superior energy resolutions are available at short shaping times, enabling the 10mm^2 SDD chip of the Apollo XV SDD to operate with low dead time even at high count rates and making it suitable for fast X-ray mapping.

Many X-ray microanalysis applications require "simple" chemical analysis, where the analyst generates chemical data from certain areas / spots of the sample. The Apollo 10 SDD is the perfect solution for these applications. The 10mm^2 SDD chip provides good energy resolutions and low energy performance providing accurate qualitative and quantitative analysis along with good X-ray mapping capabilities.



Light element performance of Apollo XV SDD.

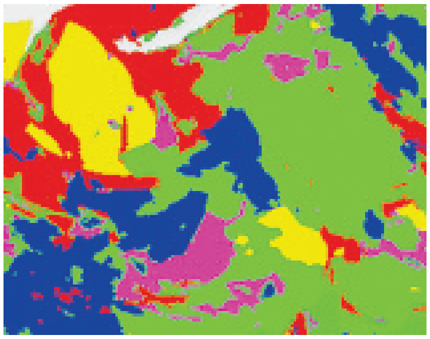
For general X-ray microanalysis applications the Apollo 40 SDD offers the best solution. The energy resolution and low energy performance, coupled with the best collection efficiency, ensure that the Apollo 40 will provide optimum performance for X-ray microanalysis applications.



Overlay of stainless steel spectra collected at 5K, 10K, 20K, 40K, 60K, 80K, and 100K, by Apollo XV SDD.

The Apollo series SDD is the perfect complement to the market-leading Genesis software, bringing all the advanced features for qualitative and quantitative analysis, mapping and particle analysis to the materials characterization scientist. The Apollo Series SDD fits seamlessly into the EDAX family of materials characterization tools, effortlessly integrating with the market-leading EBSD cameras and technology-leading WDS systems.

X-ray map collected at 100,000 cps by Apollo 10 SDD.



The EDAX Apollo SDD series offers solutions for any X-ray microanalysis application. The Apollo 40 SDD is the ideal answer for ultra fast X-ray microanalysis, providing fast spectrum collection, ultra fast X-ray mapping, and complex particle analysis. The Apollo XV SDD offers solutions where spectrum resolution is important for the most accurate qualitative or quantitative analysis or where light element performance is of primary interest while still providing fast X-ray mapping. The Apollo 10 SDD provides budget level solutions for all basic X-ray microanalysis applications, from basic spectrum analysis to fast X-ray mapping.

Finally, there is a complete range of SDDs to satisfy all X-ray microanalysis applications, enabling users to select the ideal EDS detector to solve their microanalysis problems.

TIPS & Tricks

Creating User Palettes for Eagle XRF Maps

Mapping in Vision 32 takes ED-XRF spectral data from a matrix of pre-selected points and correlates each point's intensity to a color or shade on an intensity scale. In the user palettes, custom intensity scales can be created using 64 colors or shades called indices. This option is beneficial when customizing colors for intensity scales to optimally display features in mapping results. For instance, the customizable palette allows users to separate peaks from spectral noise by bracketing intensity ranges with different colors. The Color Palette is accessed via Spectral Utilities:

- Click "Image-Utilities" in the menu, which then opens a set of maps. In the "EDAX Image Utilities – Map" window, select "Palette" drop-down, select "User Palette," click active "User Palette" icon

The "Color Palette Selection" window in Figure 1 displays 64 index boxes, labeled 0-63, as shown in region [1].

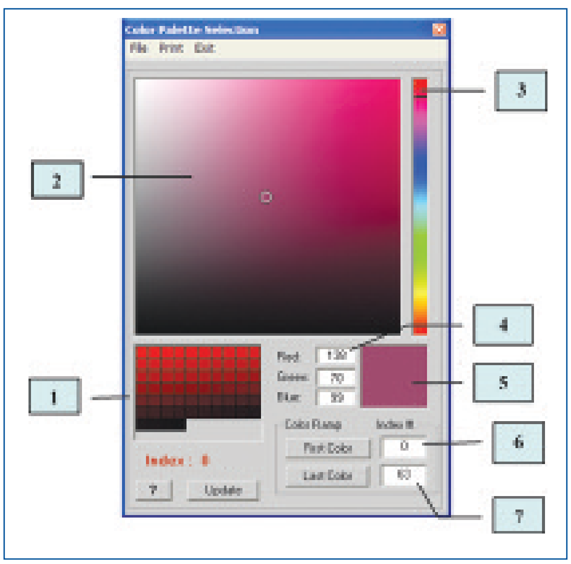


Figure 1: Color Palette Selection window.

Selecting Colors

Selecting a color for the palette can be done in two ways. One method is to use the square [2] and vertical [3] gradient displays. Slide the vertical bar to select a color, and drag-and-release the white marker in the square gradient to select a shade of that color. The second method is to enter a number between 0 and 255 into the Red-Green-Blue mixer [4] to create colors. Hit "Enter" for the resulting color, displayed in region [5].

Creating the Custom Palette

One method to create a custom palette is to select a first and last color, and "ramp" them together, which then blends the colors over a defined index range. In Figure 1, only the first 55 indices (#0-54) will be ramped. To define the starting index number, enter "0" in the Index # box next to "First Color" [6]. Next select a starting color using either of the selection methods described above, and click "First Color" to apply it. Set the ending index by entering "54" in the Index # box next to "Last Color" [7]. Select an ending color then click "Last Color," which displays the ramped palette in area [1]. The user can also alter individual indices, which is helpful for customizing smaller ranges. Indices #60-63 will be manually colored yellow to emphasize spots of high concentration. To alter the color, select the first index box, "60", left click, then select a new color. If the RGB mixer was used, click "Update" to apply the new color to the selected index. If the gradients were used, apply the new color by simply double-right-clicking on the white marker over the desired color and the respective index will change color. Repeat this for each index box. To save the color palette, select File>Save. The palette can be applied to maps in Spectral Utilities or Vision.

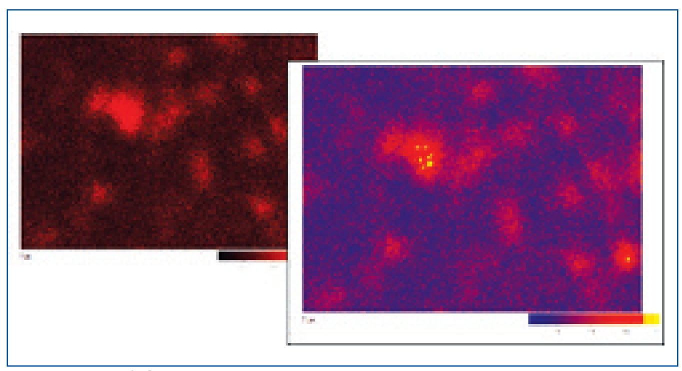


Figure 2a: Ti(K) XRF map shown in grayscale and also shown with a user palette containing areas of high concentration in yellow.

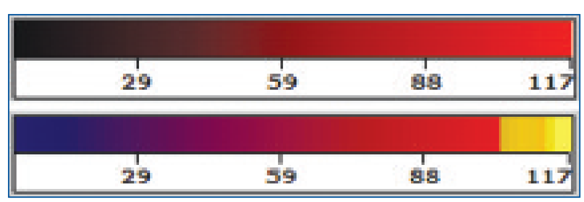


Figure 2b: User palette (above) shows grayscale for Ti(K). The custom user palette (below) employs ramped colors on the low intensity end of the palette. A few of the indices on the high intensity end have been manually altered to highlight hot spots in the map.

EBSD NEWS

Characterizing Plastic Deformation with OIM™

The automated analysis of Electron Backscatter Diffraction (EBSD) patterns for Orientation Imaging Microscopy (OIM™) can be very useful for investigating and understanding the microstructural behavior of materials that have been plastically deformed. Plastic deformation is permanent deformation that does not recover with the release of the applied force. During plastic deformation, atomic bonds are broken and then reformed. In crystalline materials, this process involves the creation and motion of dislocations. Dislocations move along specific combinations of crystallographic planes and directions called slip systems. OIM™ provides tools for analyzing both the misorientation that occurs with the formation of dislocations as well as the spatial distribution of slip systems.

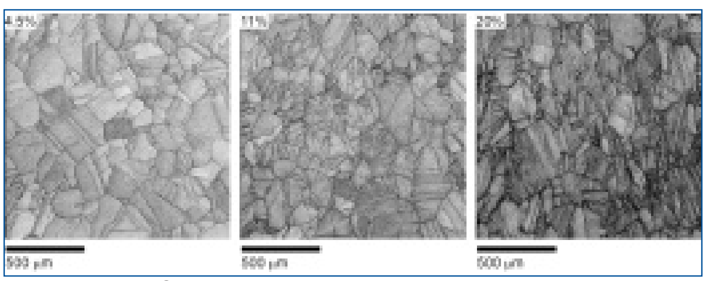


Figure 1: Image Quality maps.

For this work, specimens (provided by George Vander Voort, Buehler, Ltd.) of cartridge brass (Cu-30%Zn) were annealed and then cold rolled to 4.5%, 11%, and 20% reduction. Specimens were then mounted and prepared for EBSD, and analyzed at 200 points per second using an EDAX Hikari EBSD detector on an FEI Quanta 200 FEG SEM.

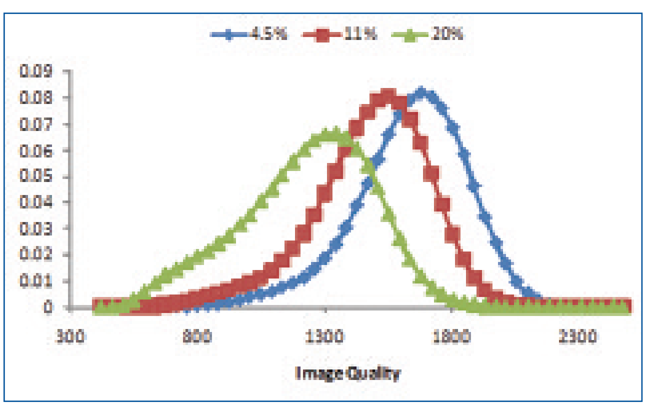


Figure 2: Image Quality distributions.

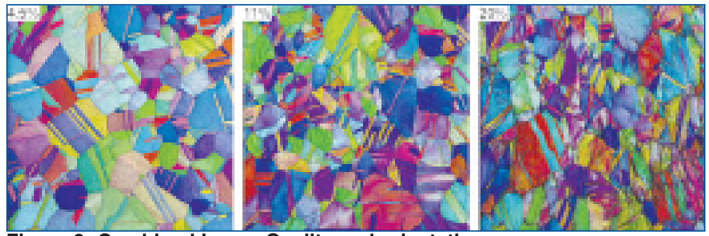


Figure 3: Combined Image Quality and orientation maps.

Figure 1 shows the Image Quality (or IQ) maps collected from each specimen with the corresponding IQ distributions shown in Figure 2. IQ is a measure of the intensity of the bands detected in an EBSD pattern. As the amount of deformation introduced into the specimens increases, the sharpness and intensity of the diffracting bands decrease due to the increased dislocation density. The average IQ decreases as seen in the maps and the overall distribution broadens. However, IQ is only a qualitative measurement, and is dependent on many variables. Figure 3 shows the IQ maps combined with orientation maps. By using the orientation measurements derived from the EBSD patterns, a more quantitative analysis of the deformation is possible.

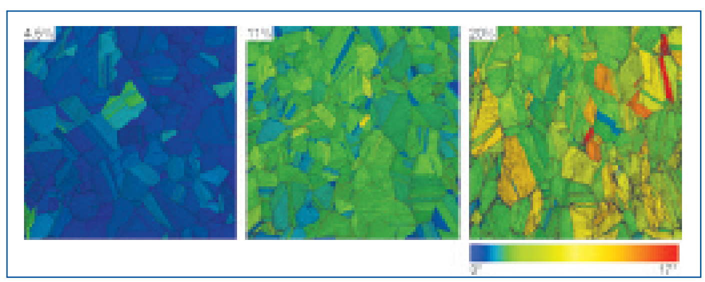


Figure 4: Combined Image Quality and Grain Orientation Spread maps.

Figure 4 shows the Grain Orientation Spread (or GOS) maps combined with the IQ maps, with the corresponding distributions shown in Figure 5. For each grain, the average orientation is first calculated. Then for each point within a grain, the misorientation between that point and the average orientation is calculated. The GOS is the average of these misorientation values. The GOS values increase with increasing deformation, again with a broadening of the distribution.

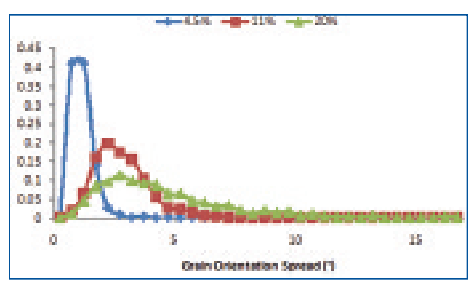


Figure 5: Grain Orientation Spread Distributions.

Characterizing Plastic Deformation with OIM™ (Cont'd. from Pg. 4)

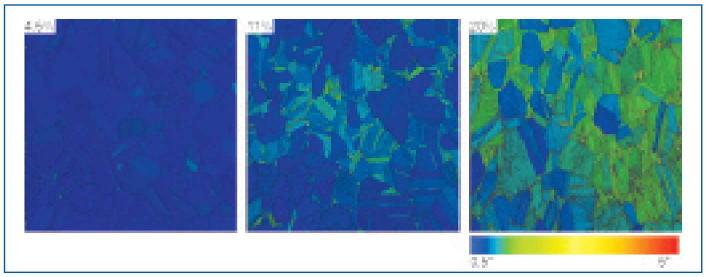


Figure 6: Combined Image Quality and Grain Average Misorientation maps.

Figure 6 shows the Grain Average Misorientation (or GAM) maps, combined with the IQ maps, with the corresponding distributions shown in Figure 7. Within each grain, the misorientation between neighboring measurements is calculated. The GAM is the average of these misorientation values. Again, an increase is observed with increasing deformation, but at 20% deformation the data suggests a tri-modal distribution of values.

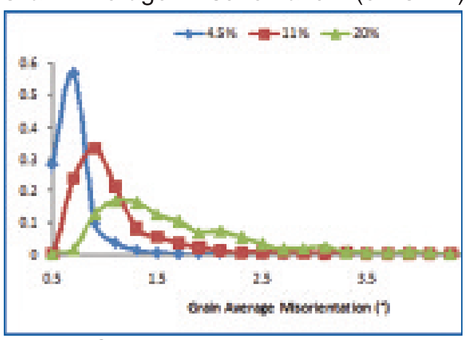


Figure 7: Grain Average Misorientation Distributions.

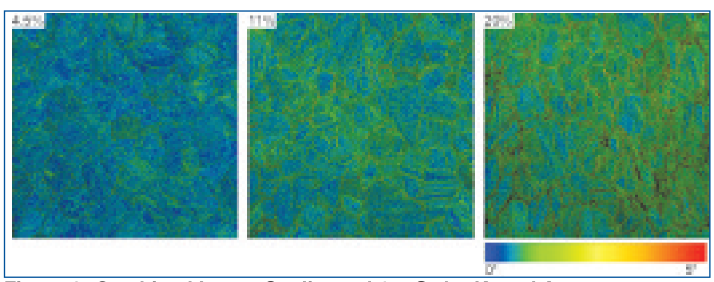


Figure 8: Combined Image Quality and 1st Order Kernel Average Misorientation maps.

Both the Grain Orientation Spread and Grain Average Misorientation measurements generate averaged information for each grain within the measurement area, but give no information on the localized structure within a grain. For this type of analysis, a kernel based approach is used. The Kernel Average Misorientation (or KAM) calculates the misorientation between a center point and all the points at the perimeter of the kernel specific to that point. The value is calculated for each point in specified value (5° in this case), that misorientation is excluded to focus on internal structure. The size of the kernel is specified by the order of the neighboring points. For example, Figure 8 shows the 1st order KAM maps where the misorientation is calculated for adjacent measurements while Figure 9 shows the 4th order KAM maps where the misorientation is calculated between each point and its neighbors are 4 measurements away in each direction. These measurements are useful for investigating the scale and development of orientation gradients within grains. It is also possible to calculate GOS and GAM values on a specified kernel scale. These are termed Local Orientation Spread and Local Average Misorientation. Each of these provides a point-specific measurement of the local misorientation distribution.

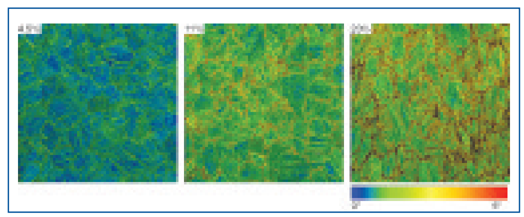


Figure 9: Combined Image Quality and 4th Order Kernel Average Misorientation maps.

One may also explore the effects of the spatial distribution of the crystallographic slip systems relative to the loading direction of the applied force. In this case, the slip is expected to occur on the {111} planes along the <110> directions. Figure 10 shows the Taylor Factor maps for these microstructures subjected to rolling deformation. The lower the Taylor Factor values, the easier it is for slip to occur. While often an average Taylor Factor is used to represent the microstructure, knowing the localized Taylor Factors helps to determine places where stress concentrations may occur due to Taylor Factor mismatch.

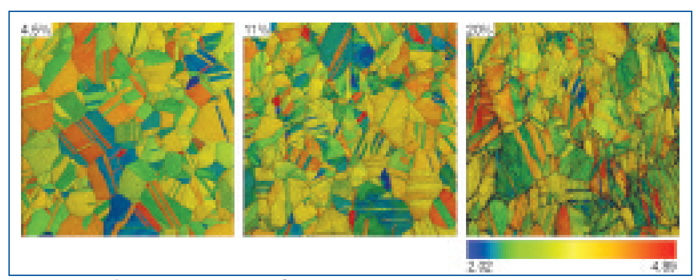


Figure 10: Combined Image Quality and Taylor Factor maps.

These examples are designed to introduce the analytical capability of OIM™ for investigating deformed materials. The effects of twinning, grain size and shape, and preferred orientation could also be included using the full suite of tools with OIM™ Analysis.

TRAINING AND EVENTS

World-Wide Events (thru October 2008)

April 01-04	Analytica 2008	Munich, Germany
April 15-17	Scanning	Gaithersburg, MD
April 16-18	The Southeastern Microscopy Society	Pensacola, FL
April 17	AIMS (Arizona Imaging & Microanalysis Society)	Flagstaff, AZ
April 22-25	Control 2008	Stuttgart, Germany
May 01-03	NESM (New England Society for Microscopy)	Woods Hole, MA
May 20-21	Microbeam Analysis Society (Meeting)	Madison, WI
June 01-13	Lehigh School	Bethlehem, PA
June 02-08	Scandem	Copenhagen, Denmark
June 02-06	ICOTOM (International Conference on the Textures of Materials)	Pittsburgh, PA
June 16-20	EXRS (European Conference on X-ray Spectrometry)	Cavtat, Croatia
June 23-26	Microscience	London, UK
July 23-26	MSSA	Botswana
August 4-6	Denver X-ray Conference	Denver,CO
August 4-7	M&M (Microscopy & Microanalysis)	Albuquerque, NM
September 1-5	EMC 2008 (14th European Microscopy Conference)	Aachen, Germany
September 8-10	ICAM 2008 (9th International Congress for Applied Mineralogy	Brisbane, Australia
October 6-9	MS&T (The Materials Science & Technology Expo.) (Formerly called ASM)	Pittsburgh, PA

***Please see our website, www.edax.com for a complete list of our tradeshows

World-Wide Training

To help our present and potential customers obtain the most from their equipment and to increase their expertise in EDS microanalysis, WDS microanalysis, EBSD/OIM and Micro-XRF, we organize a number of Operator Courses at the EDAX facilities in North America; Tilburg, NL; Wiesbaden, Germany; and Japan.

Europe

Tilburg = (T) (in English)
Wiesbaden = (W) (in German unless stated otherwise):

Microanalysis Courses:

3-4 Day

- May 26-29 (T)
- June 17-20 (W)
- August 25-28 (T)
- November 17-20
- November 25-28 (W)

2 Day

- April 10-11 (T)
- May 22-23 (T)
- September 4-5 (T)

LEX Course:

- October 7-9 (T)

TEX Courses:

- September 9-10 (W)
- September 23-24(W)

Pegasus Courses:

- April 14-18 (W)
- October 20-24 (W)

OIM™(EBSD) Courses:

- May 19-21 (T)
- September 8-10 (T)

Japan

Microanalysis Courses:

- April 2-4 Osaka
- June 4-6 Tokyo
- July 2-4 Osaka
- October 1-3 Tokyo
- November 5-7 Osaka

For more information on our training classes, please visit our website at: **www.edax.com/service/user.cfm**

North America

Microanalysis Courses:

- April 21-25 Mahwah, NJ
- June 23-27 Mahwah, NJ
- July 21-25 Mahwah, NJ
- September 22-26 Mahwah, NJ
- October 27-31 Mahwah, NJ
- December 1-5 Mahwah, NJ

Particle Courses:

- May 13-15 Mahwah, NJ
- November 11-13 Mahwah, NJ

WDS Courses:

- November 18-20 Mahwah, NJ

EBSD OIM™ Academy Courses:

- April 29 - May 1 Mahwah, NJ
- August 26-28 Mahwah, NJ
- October 14-16 Draper, UT

Micro-XRF Courses:

- April 15-17 Mahwah, NJ
- October 7-9 Mahwah, NJ

Mark Massey is based in the EDAX office located in Tilburg, The Netherlands. As the General Manager for EDAX B.V., Mark is responsible for the EDAX business in Europe. He was born in the North of Wales, UK and raised in The Netherlands. He holds degrees in Electronics Engineering and Business Administration.

Mark began his career with EDAX in April 1996 after working for several years with Topcon as a Sales Manager for the Electron Microscope products group. His early focus at EDAX was in sales support to a limited distributor network in Europe for a very small product range, the DX-4 EDS Microanalysis System and the DX-95 EDXRF Analyzer. As the EDAX product range expanded rapidly over the years with new products in EDS, WDS, EBSD and MicroXRF, Mark was instrumental in developing today's European team with a direct sales and service organization in Benelux, Germany, Nordic, UK and an extensive distributor network throughout the European region.

During his years with EDAX, Mark has travelled quite extensively throughout the region. He very much enjoys meeting with customers and sales partners in different cultures, listening to their requirements, and working hard to fulfill their needs.

During the summer, Mark likes to bicycle in the country with his friends and when time allows in the winter, he enjoys the fresh powder snow in the Alps on his snowboard. He also enjoys being home with his wife Ingrid and their children Jasper (11) and Melissa (7). For the past 5 years now, Mark has been coaching Jasper's soccer team on Saturdays.

Pete Carrara joined EDAX in September 2004 and works out of the Mahwah, NJ Corporate Office. He brings 30 years of manufacturing supervisory experience to EDAX. Pete attended RETS Electronic School and Newark State (Kean College). He also studied manufacturing at Bloomfield College in Bloomfield, NJ.

Pete worked as a Bench Tech at Varityper where he worked his way up to Supervisor of Manufacturing on second shift. He moved to Electronic Test Supervisor on first shift. Pete pursued his career and worked for Fabricated Components in Strousburg, PA as the Manufacturing Supervisor prior to joining EDAX.

Pete started his career at EDAX as a Detector Unit (DU) Supervisor, responsible for managing the DU assembly and test area. In this department crystals are manufactured and the DUs are assembled, tested, and prepared for shipping. Pete recently moved to the Analyzer, Assembly and Test department as the Analyzer Production Supervisor where he oversees system building and testing as well as cable building and harness and PC board testing. He also supervises the machine shop. Pete is also a member of the EDAX First Aid Team.

Pete has been married for 32 years to his wife Patty. They have two adult children Kim and Peter. He has just become a new grandfather to Ava Marie. In his spare time, Pete likes to golf, go crabbing, and spend his summers at the beach.

CUSTOMER NEWS

Beijing University of Technology

Beijing University of Technology (BJUT) is a key university under the jurisdiction of Beijing Municipal Government. Founded nearly half a century ago, BJUT has established a multidisciplinary academic structure, among which the faculties of Materials Science & Physics have lead China with abundant innovative achievements in recent years.

In 2003, the Institute of Microstructure and Property of Advanced Materials of the University introduced its first EDAX Pegasus (integrated EDS and EBSD) and a Genesis XM2. The Pegasus system was mounted on a JEOL 6500 FEG SEM, and the Genesis XM2 on a FEI Quanta 200. The Institute has 12 faculty members and 10 post-graduate students, led by Prof. Z. Zhang, an Academician of CAS. The research programs of the Institute are focused on the microstructure, properties and applications of advanced materials, most of which are supported by various state funds, including the Natural Science Funds. The SEMs serve not only the research programs in the Institute and the University, but also the universities in Beijing and around China. Over the years, abundant achievements were acquired with the facility under the management of Prof Ji-Yuan. About 30 EBSD/OIM related papers have been published, in which results from the facility were presented.

When BJUT purchased EDAX equipment, EDAX and the Institute reached an agreement to use the BJUT facility as a joint co-operation platform as well as a demo lab for EDAX OIM/EDS. Since then, several EDAX EBSD/OIM training courses have been held in the laboratory.

In 2007 Key Laboratory of Advanced Functional Materials Ministry of Education in the School of Materials at BJUT introduced a new Pegasus with the most advanced high speed Hikari EBSD camera mounted on an FEI NanoSEM. Prof Zhang Jiu-xing is the director of the laboratory. His research programs have an important position in the material science field in China. The major user of the SEM is Prof Liu Dan-min, who has been using EBSD/OIM for years, studying the micro-textures of Mg alloys, Ag, Ni alloys, superconducting plate materials and others. Since its installation and acceptance, the new facility has been in full operation for characterization of advanced materials.

BJUT is pleased with the service and technical support provided by EDAX. The EDAX China team, Prof. Ji, and Prof. Liu are determined to make their facilities into the model co-operation platform and demo center in China.

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EDAX advanced microanalysis solutions
AMETEK MATERIALS ANALYSIS DIVISION

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