EDAX FOCUS

TEAM™ Smart Phase Mapping

Introduction

EDAX's revolutionary Phase Mapping included in the new TEAM™ software makes it possible for the user to observe phase information while the maps are collected. This new approach to mapping allows for all users to quickly, easily, and accurately determine phases.

Traditionally, X-ray mapping involves the creation of multiple elemental maps. Historically, these maps were used by the operator to interpret phases after the maps were collected. As a result, different operators would make different interpretations.

Live Phase Mapping

Previously, the analyst would need three steps in order to complete their analysis – data collection, phase analysis, and interpretation. TEAM™ phase mapping allows these tasks to be simultaneously combined during analysis.

Live phase mapping determines phases while the primary map data is collected. A separate processing step after collection is no longer required. Prior knowledge of the sample chemistry is not needed and parameters no longer need to be defined. A comparison of the composition at each pixel begins in the very first 'pass' or frame of the analysis (Figure 1b). The quality of the phase definition improves with subsequent frames as seen in Figures 1b-1f. Spectra of each phase are saved at the end of the analysis (Figure 2) and the phases are easily quantified.

(Cont'd on Pg. 2)

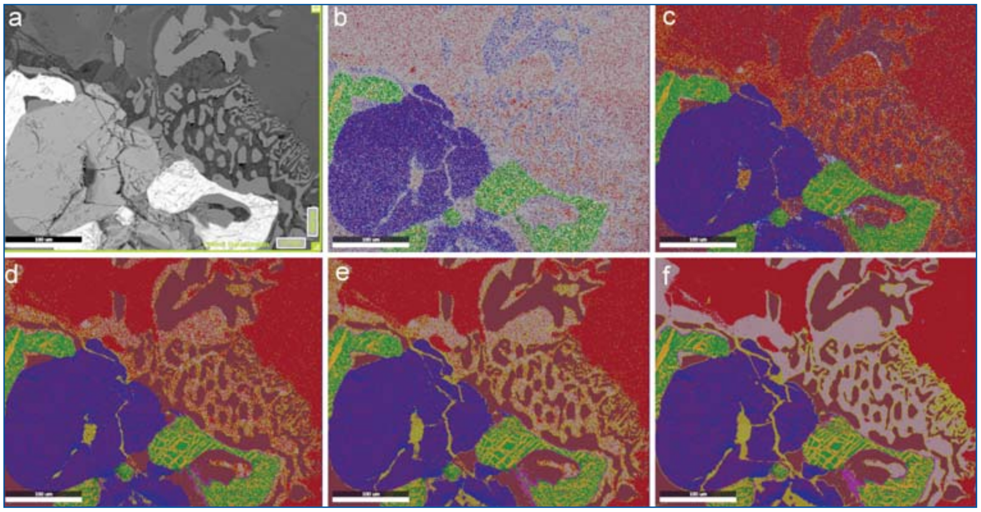

Figure 1 - The sequence of collecting a live phase map is shown. First, an image is collected ('a') and then the map starts. The phase map shown in 'b' is after only a few frames and the maps which follow are in sequence. Note that the images become less noisy over time and some areas change from one phase to another - the blue mottled area in the upper part of 'b' gradually changes to a reddish brown phase. Each phase is named or defined by the dominant elements present.

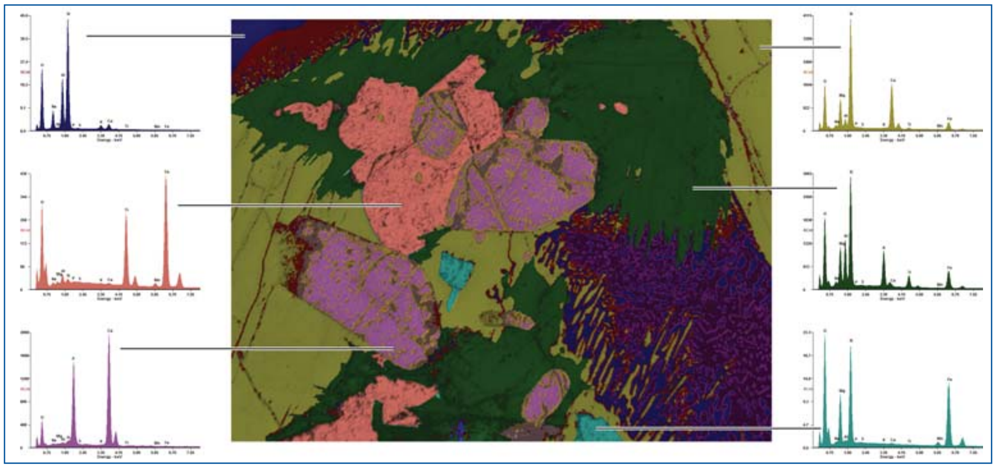

Figure 2 - Phase map of a geological sample showing the composition of 6 of the phases present. The phases are named based on the dominant elements present and each phase represents a different mineral (e.g. feldspar, mica, pyroxene, apatite, etc.).

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TEAM™ Smart Phase Mapping (Cont'd. from Pg. 1)

Element Mapping

In addition to the collection of live phase maps, it is still possible to see the elemental maps for each element. The number of elemental maps is no longer a limitation.

The color pallet for each map is pre-defined, though it is possible for the user to change the pallet. Another mapping option is the Counts Per Second (CPS) map. The CPS map provides a contrast that is based on the total count rate at each pixel. Areas with the highest count rate will be the brightest in the map. All images are easily exported to a standard file format.

Interactive Phase Mapping

A unique feature in Smart Phase Mapping allows the user to interact with the dataset during collection. The user can determine which phases are present during the initial analysis. Interpretation of the spatial relationship in phases is often very helpful in understanding the sample or feature origin.

Comparisons can be made between a phase map and an elemental map. Phase spectra can then be examined while mapping (Figure 3). The interactive pie chart allows the user to evaluate the phase composition. The phase map is also interactive. The user can click on an area of the map to see which phase in the pie chart is represented by that area. The summary phase spectrum is generated from the pie chart. The phase map can also be compared to the total X-ray intensity map to determine if an anomaly coincides with topographic features such as a crack, pit, or a depression.

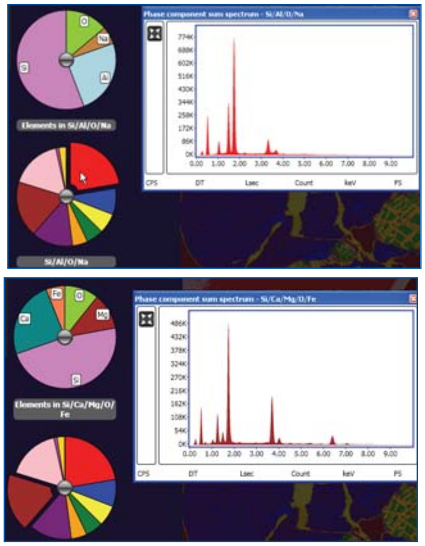


Figure 3 - Phase spectra can be viewed during map collection by pressing the right mouse button on the colored phase of the pie chart. A left mouse click on the same area will show a pie chart of the significant elements present in the phase. The dominant elements in the red phase (upper image) are Si, Al, O, and Na. The dominant elements in the reddish brown phase (lower image) are Si, Ca, Mg, O, and Fe.

What are Smart Features?

Smart features allow all users to be confident in the quality of the data they are generating.

Smart Features permit a user to:

- Collect data with minimal setup
- Predict or calculate optimal parameters
- Receive guidance and suggestions on how to optimize microscope parameters
- Avoid the possibility of collecting incorrect or misleading data
- Have parameters dynamically adjusted during an analysis when it makes sense to do so
- Collect quality data in an efficient manner

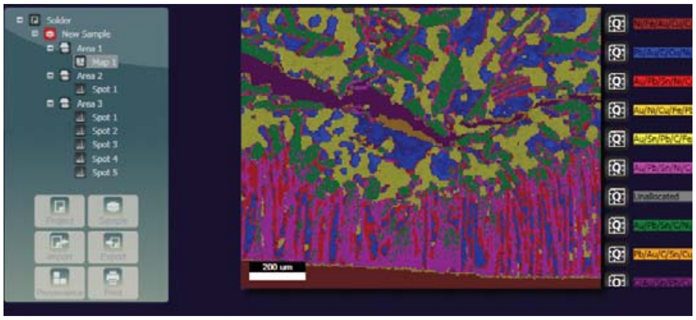


Figure 4 - Phase map of a complex, multi-phase solder. The color key for each phase is shown to the right of the phase map. It is possible to quantify the summary spectrum of each phase by clicking on the "Q" button.

Conclusion

In the TEAM™ software, phase maps (Figure 4) are automatically generated without input from the user. Parameters do not need to be specified and it is not necessary to provide information or knowledge of the sample. The benefit to the user is that no additional investment of time is needed during map collection.

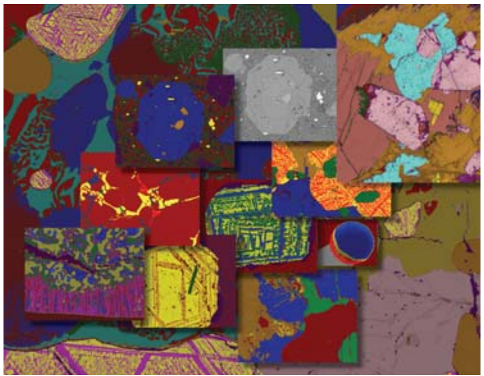
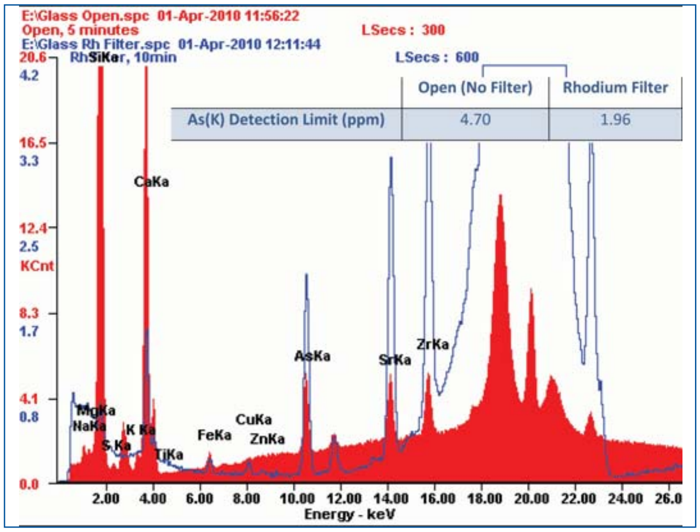


Figure 5 - A variety of phase maps are overlain and shown as a collage.

Primary X-ray Beam Filters for Micro-XRF

EDAX's Orbis μ-XRF spectrometers are now available with a selection of six primary X-ray beam filters as a standard feature on all systems, providing more analytical capabilities than ever before. The filters are attached to a wheel, and the filter material can be easily selected through the Vision software. This feature allows artifact peaks, such as Bragg diffraction peaks and tube scatter peaks (i.e. Rh scatter peaks), to be eliminated from overlapping with elemental peaks. Background noise can also be lowered to significantly improve detection limits. Filters can also be used while acquiring spectral maps and line-scans, and in conjunction with the Fundamental Parameters quantification routines (with or without standards). A particular advantage of the Orbis' filtering system is that the primary beam filters must be positioned between the X-ray tube and the focusing optic. This design allows the X-ray to first be filtered, and then focused, whereas filters placed after the focusing optic will simply re-scatter the X-ray beam. In addition, any of the six filters can be used with any one of EDAX's X-ray optics while still producing high count-rates, providing the versatility necessary to get the best results possible in a shorter period of time.

Each filter is made of a different material and is capable of "cleaning" up a different energy region (keV) of the XRF spectrum. Having all six filters available on an automated wheel will allow the user to find a suitable filter for any energy region. Filter selection is based on the attenuation characteristics of the material itself, along with the energy region of interest. As mentioned, selecting the correct filter can greatly reduce spectral background and improve the peak-to-background ratios for the elements/region of interest. As shown in Figure 1, the lower limits of detection for As(K) are greatly improved when comparing the results from an open configuration (red spectrum) versus an Rh filter (blue spectrum).



	Open (No Filter)	Rhodium Filter
As(K) Detection Limit (ppm)	4.70	1.96

Figure 1 – Detection limits for As(K) in this glass standard improve by more than a factor of two when using the Rh filter (blue spectrum) versus using no filter (red spectrum).

A practical example using primary beam filters is shown below, where a supposed Pb-free solder paste was analyzed to verify the presence or absence of Pb. The paste analyzed without a filter (open) showed two small bumps where Pb(L) and Br(K) would be located. Due to the high background noise, it is difficult to confirm them as elemental peaks or spectral noise. However, by re-acquiring with the Rh filter, the Rh attenuated the background noise present around the region of Pb(L) and Br(K), allowing the elemental lines to become clearly visible via fluorescence from higher-energy X-rays. The peak-to-background ratio improved by a factor of 42.5 for Pb(L) and a factor of approximately 28.8 for Br(K), marking a significant improvement. More importantly, the Pb and Br could have been left unseen in the solder if the system did not have filters that were as versatile.

(Cont'd on Pg. 4)

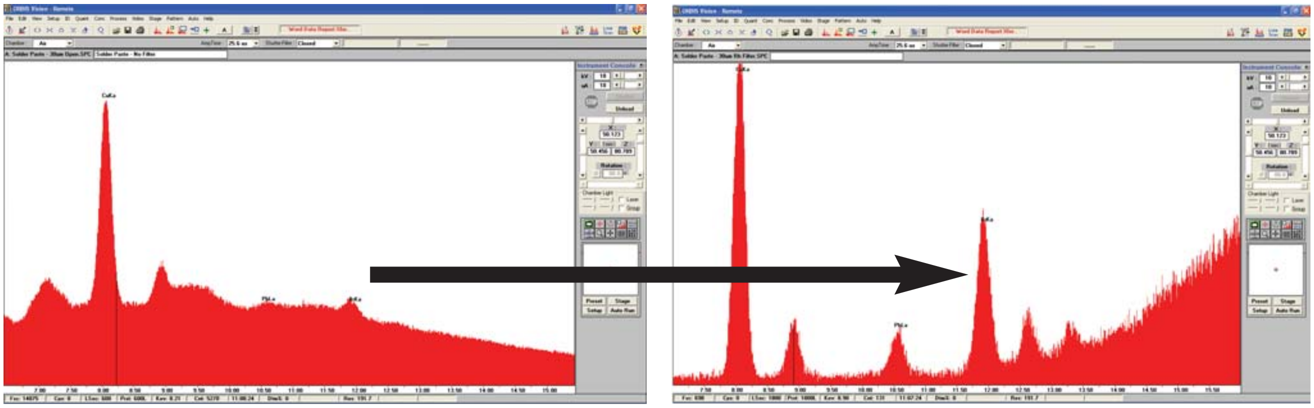


Figure 2 – The first spectrum acquired with no filter shows high background near Pb(L) and Br(K). The spectrum on the right, acquired with a Rh filter shows clear Pb(L) and Br(K) peaks, with significantly better peak to background ratios.

Primary X-ray Beam Filters for Micro-XRF

(Cont'd. from Pg. 3)

Spectral imaging (mapping) is also another feature than can benefit greatly from implementing filters. Because an unwanted artifact peak (i.e. Rh(L) tube scatter peak) can overlap with an element of interest (i.e. Chlorine), the system may register that artifact peak as an elemental intensity, causing features to appear on the maps that do not actually exist in the sample. In this particular example, Cl(K) distribution was mapped to observe the corrosion on a stainless steel alloy. When mapped without a filter, the Rh(L) interferes with the Cl(K) signal, causing higher Cl(K) intensities. However, by re-acquiring it with a thin aluminum filter, the resulting image shows the true elemental intensities, with interference from artifact peaks eliminated. The count rate was not sacrificed, and remained adjusted for about 40% dead-time. Being able to run the filters while maintaining a high count rate allows high quality maps to be acquired in a shorter time.

Being able to utilize primary beam filters remains an important tool for μ-XRF, as there are many uses and benefits to having them available for a variety of applications. By improving detection limits and eliminating high background and artifact peaks, the primary beam filtering system provides more analytical capability than ever before. With the primary beam filter system offered as a standard feature in conjunction with any Orbis X-ray optic, the Orbis Spectrometer provides the end user with more options and better results.

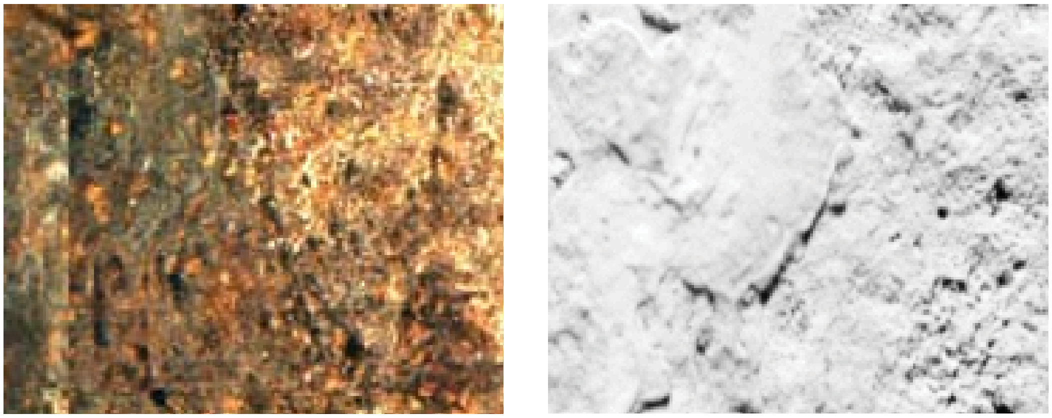


Figure 3a – Original video image and total counts map for the corrosion surface.

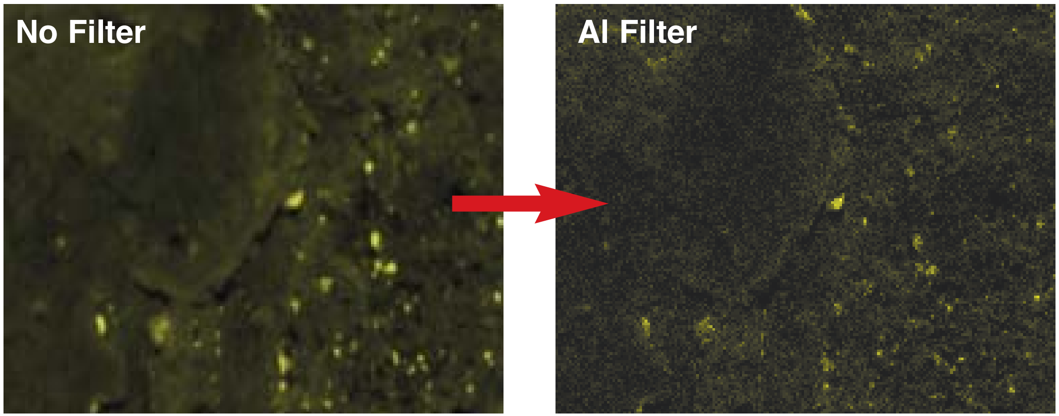


Figure 3b – The map taken with no filter (left) shows more noise and supposed Cl(K) hotspots. When taken with a thin aluminum filter (right), the noise is eliminated, and the true Cl(K) intensities are mapped.

Image Processing (Enhanced) for EBSD Analysis

An EBSD pattern as recorded on the phosphor screen is very weak. The majority of electrons that hit the screen do not carry the diffraction information that we can use to determine the orientation of a grain. For successful EBSD analysis it is necessary to remove this background signal from the pattern.

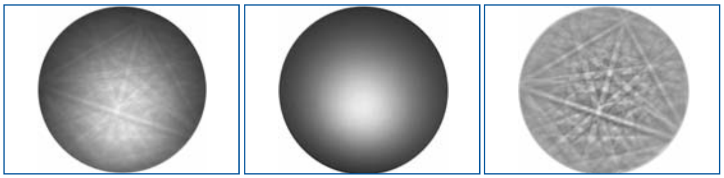
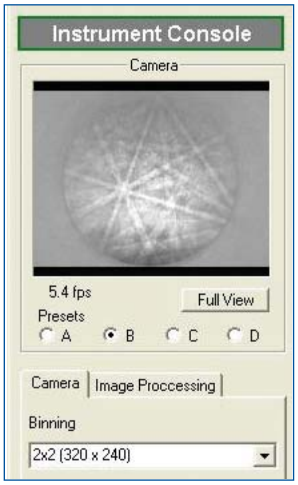


Figure 1 – EBSD pattern from ferrite. Left: EBSD pattern as detected, middle: background reference image, right: pattern after background subtraction.

The standard procedure for pattern enhancement is applying a "background subtraction". A background reference image is collected that only displays the intensity distribution that is caused by the average composition (like backscatter contrast) and surface orientation. EBSD bands have to be avoided in the background image which is usually done by averaging the signal from a large number of grains. When this background signal is subtracted from the original pattern, the illumination becomes more homogeneous and the bands show improved contrast.



Binning: 2x2 (320 x 240)

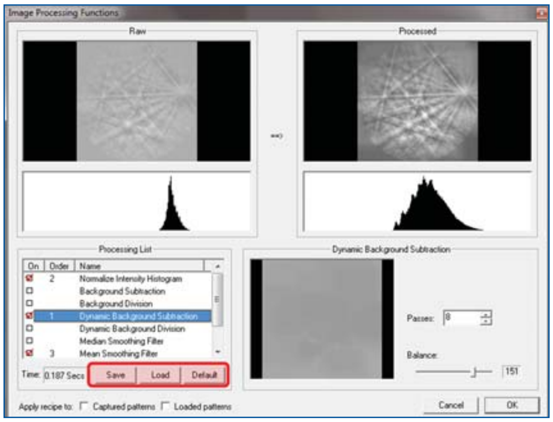
Figure 2 – Instrument console in OIM™ DC with presets for the different camera settings.

The background image must have the same pixel resolution as the EBSD pattern that needs to be processed. The OIM™ Data Collection software allows the user to collect a background for all the available camera resolutions. When choosing a camera (binning) preset, the appropriate background image is automatically selected.

In most cases patterns that have been processed by background subtraction can be analyzed successfully.

When background subtraction is not enough, for example, when the specimen surface is not flat or when the grains are so large that a background image without bands cannot be recorded, additional image processing can be applied. Enhanced image processing is also useful on specimens that generate very weak patterns, e.g. due to surface oxidation or a conductive coating.

The OIM™ Data Collection software offers a range of different image processing tools where the operator can define a custom image processing recipe for pattern optimization. These enhanced background processing tools include dynamic background calculations, noise reduction by image smoothing, background division, and a histogram normalization to improve the contrast. A processing recipe can be setup by clicking the options in the desired order.



On	Order	Name
☒	2	Normalize Intensity Histogram
☐		Background Subtraction
☐		Background Division
☒	1	Dynamic Background Subtraction
☐		Dynamic Background Division
☐		Median Smoothing Filter
☒	3	Mean Smoothing Filter

Time: 0.187 Secs

Passes: 8

Balance: 151

Apply recipe to: ☐ Captured patterns ☐ Loaded patterns

Figure 3 – Enhanced image processing window.

Similar to polishing, different materials may require different recipes for pattern optimization and it may take some experimenting to find the optimum recipe for individual specimens. A general recipe that works well on low contrast patterns collected at 1x1 and 2x2 binning is:

-1- Background subtraction
-2- Smoothing
-3- Dynamic background subtraction
-4- Histogram normalization

For lower resolution patterns the smoothing step can be left out. When a good background recipe has been found this can be stored for later use in the image processing window. Also, each of the camera preset buttons support the storage of a dedicated processing recipe.

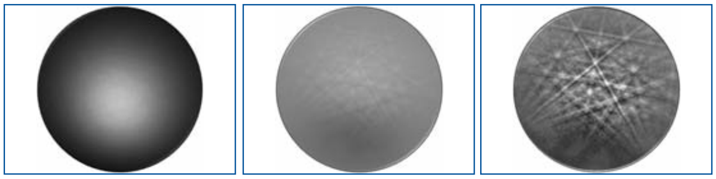


Figure 4 – Difference between standard background subtraction and enhanced processing on an oxidized magnesium alloy specimen. Left: EBSD pattern as detected, middle: pattern after standard background subtraction, right: pattern after enhanced processing using the recipe given above. The enhanced processing allows successful scanning of the sample.

TRAINING AND EVENTS

World-Wide Events

May 17-19	Scanning	Monterey, CA
May 24-26	MAS (Microbeam Analysis Society)	Madison, WI
May 24-26	Japanese Society of Microscopy at Nagoya	Nagoya, Japan
July 5-9	IPFA 2010	Singapore
July 11-15	ACMM21	Brisbane, Australia
July 13-15	Semicon West	San Francisco, CA
August 1-8	M&M (Microscopy & Microanalysis)	Portland, OR
September 1-3	JAIMA Expo 2010	Chiba, Japan
September 19-22	Micro & Nano Engineering	Genda/Italy
September 19-24	IMC17	Rio, Brazil
October 17-21	MS&T (The Materials Sci. & Tech. Expo.) Formerly called ASM	Houston, TX
November 29 - December 3	MRS (Materials Research Society)	Boston, MA

***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):

EDS Microanalysis:

- June 1-3 (T)
- June 17-18 (T)
- September 14-16 (W)
- September 16-17 (T)
- September 21-23 (W)
- September 28-30 (T)
- November 11-12 (T)
- November 23-25 (T)

EBSD:

- June 14-16 (T)
- September 13-15 (T)
- November 16-19 (T)

WDS (LEX):

- October 12-14 (T)

WDS (TEXS):

- May 4-6 (W) English

Pegasus:

- June 21-23 (W)
- October 18-22 (W)

Japan

Microanalysis Courses:

◆ June 9-11	Tokyo
◆ July 7-9	Osaka
◆ October 6-8	Tokyo
◆ November 10-12	Osaka

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

North America

EDS Microanalysis:

◆ June 22-24	Mahwah, NJ
◆ July 13-15	Draper, UT
◆ September 14-16	Mahwah, NJ
◆ October 18-22	Mahwah, NJ
◆ November 9-11	Mahwah, NJ

EBSD OIM™ Academy:

◆ August 24-26	Mahwah, NJ
◆ October 5-7	Draper, UT

Micro-XRF: (Orbis only)

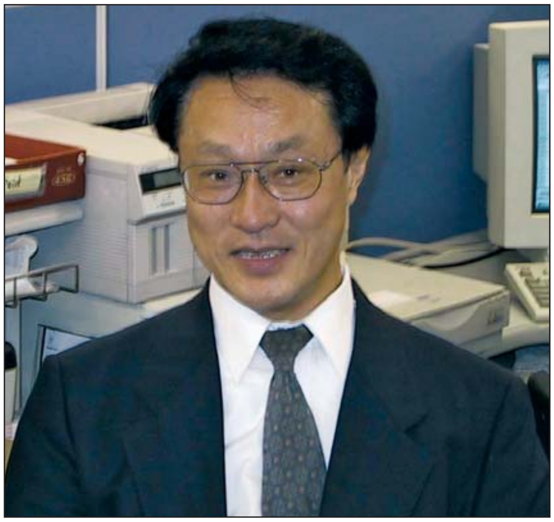
◆ September 28-30	Mahwah, NJ

EMPLOYEE SPOTLIGHT

Desmond Romans joined EDAX, Inc (P.E.I.) in Mahwah, NJ in 1988 as a Systems Technician, testing image and pulse processing boards for EDS systems. In 2000 he joined the Engineering Department as a Systems Engineering Technician working on engineering projects, prototypes, and AutoCAD drawings. Desmond is now an XRF Systems Technician. He is responsible for testing of the Orbis and Eagle III XRF systems.

Desmond was born in Jamaica, W.I. and was raised in the Bronx, New York. He later attended Fairleigh Dickinson University in Teaneck, N.J. where he majored in Electrical Engineering. He completed the Eagle training course and received recognition for his creative ideas in CPU Testing. In 2009 he started testing the new Orbis XRF systems. Desmond has been involved with testing and configuration of EDAX products for 22 years.

In his spare time, Desmond enjoys going to movies with his wife Yolanda, playing chess, painting abstract art and attending musical events in New York City.



Tomonobu Tateyama joined EDAX in 1982. Tateyama-san's career began with EDAX in the service department as a Service Engineer.

As a Service Engineer, Tateyama-san supported customers in all of South East Asia. He currently is responsible for our customers in the role of Service Manager. After 28 years of service, Tateyama-san has acquired a vast amount of product knowledge and is a dedicated and valuable employee.

Tateyama-san is committed to the success of EDAX's customers and wishes to provide the very best service. As the manager of the service department, he has built a strong team of skilled and dedicated engineers. Tateyama-san believes EDAX offers excellent customer support.

Tateyama-san was born in Akita Prefecture, Japan. He attended Kogakuin University where he earned a degree in electronics. Tateyama-san is married with two children, one son and one daughter. He enjoys spending his free time with his family. Both Tateyama-san and his wife enjoy skiing and swimming in their free time.

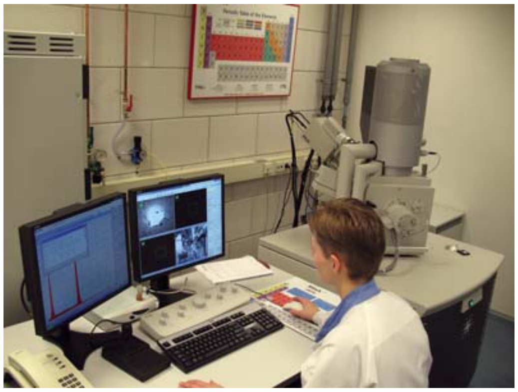
CUSTOMER NEWS

MASER Engineering, Enschede, the Netherlands

MASER Engineering is an engineering support and service provider for the micro-electronics industry. The company's focus is on reliability testing and physical analysis of electronic components, modules, systems, and materials.

Fabless semiconductor manufacturers continue to use more advanced sub-100 processes for their chips. Their mainstream manufacturing is subcontracted to wafer foundries and assembly and test service providers. They also have limited capabilities for device qualification and failure analysis. In 2008, MASER Engineering extended the range of sample preparation, microscopy, and fault localization tools for advanced failure analysis support on sub-100 nm devices with over 15 new systems. They now operate one of the most advanced independent F/A laboratory services in Europe.

MASER Engineering has chosen EDAX systems on all of their Scanning Electron Microscopes (SEM). The three FEI SEM's are the Inspect S, the Nano-SEM 230 FEG, and the Quanta 3D FEG dual beam. They all have an EDAX Genesis XM2i system that include high-resolution live spectral mapping and drift correction packages.



FEI NanoSEM 230 with EDAX XM2i and Apollo 40 SDD.

The EDX detection is performed by the Apollo-40 Silicon Drift Detector. MASER Engineering benefits from the reduced maintenance of the Peltier cooled detector for their day-to-day business needs. MASER Engineering also has a FEI Tecnai G² F20 XTWIN, Transmission Electron Microscope (TEM) equipped with an r-TEM detector and an integrated EDX analysis package.

FEI Tecnai G² F20 XTWIN with EDAX r-TEM detector.

MASER Engineering sees the benefits of the integration of the STEM/EDX operating interface. They are happy with the level of experience and the support they receive for training and operational questions from the local EDAX office.

The main application at MASER Engineering is the qualification and quantification of foreign materials found during the failure and construction analysis of semiconductor components. The complex mix of isolating and conductive materials with very small geometries is a challenge for the SEM/EDX systems. The results that this technology is able to provide are very important feedback for investigating yield improvement measures and filed return analysis.

The EDAX systems are very user friendly. This easy to use software interface allows them to share the SEM/EDX systems with multiple engineers and technicians. The move to the EDAX systems has allowed them to experience operational savings due to the ease of use.

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AMETEK®
MATERIALS ANALYSIS DIVISION

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advanced microanalysis solutions

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