EDAX FOCUS

EDAX Launches the New Hikari XP EBSD Camera

Inside This Issue

Vol.10 No.2

One Solution for all EBSD Applications

EDAX introduces the Hikari XP, the next generation in high performance EBSD cameras. Unlike traditional EBSD camera offerings that are positioned either as "fast" or "sensitive", the Hikari XP offers outstanding performance across the full range of EBSD applications. The Hikari XP blends market-leading speed, sensitivity and precision in one camera and, when paired with EDAX's TEAM™ EBSD software, the Hikari XP delivers the highest indexing success rates on the market, guaranteeing the user the best possible data quality.

Results without Compromise
The key parameters for an EBSD camera are speed, sensitivity, and precision with the Hikari XP specs shown in Figure 1.

Speed	Sensitivity	Precision
650 indexed patterns per second (ipps)	>99% indexing success at 100 pA >99% indexing success at 5 kV	<0.1 degrees

Figure 1: Key Parameters of EBSD Cameras.

Speed
The Hikari XP has a maximum speed of 650 indexed patterns per second (ipps), achievable at a beam current of 5 nA, (Figure 2). This is a 45% increase over the previous generation camera and will allow the user to increase sample throughput as well as minimize the effects of sample drift and reduce damage on beam sensitive samples.

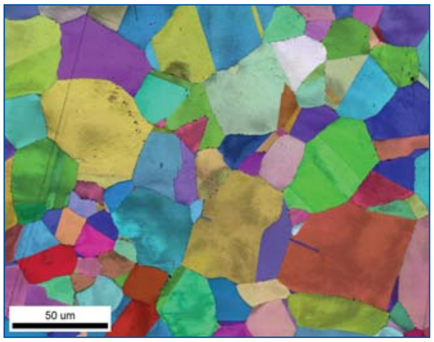

Figure 2: Inconel 600 at 650 ipps.

Sensitivity
Sensitivity has become a more critical factor in EBSD camera selection. As sample materials move to the nanoscale, the ability to analyze them at that level imposes new demands on hardware. The Hikari XP excels in the low current and low accelerating voltage conditions that are often needed to resolve nano-scale features. At a beam current of only 100 pA, the Hikari XP camera paired with TEAM™ EBSD software is able to index patterns at a 99% success rate (Figure 3).

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EBSD NEWS

EDAX Launches the New Hikari XP EBSD Camera (Cont'd. from Pg. 1)

Similarly, at 5 kV, the indexing success rate remains at 99%, allowing the user to optimize the microscope conditions for sample needs, not the needs of the camera.

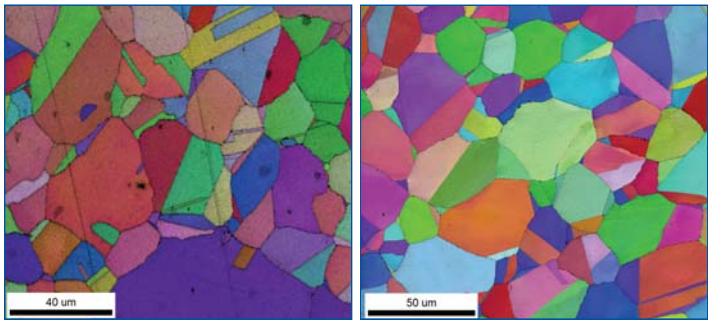

Figure 3: 99% indexing success at 100 pA and 5 kV, respectively.

Additionally, this sensitivity allows higher success rates on microscopes that are inherently lower in beam current as well as on samples that are non-conductive or easily damaged by the electron beam.

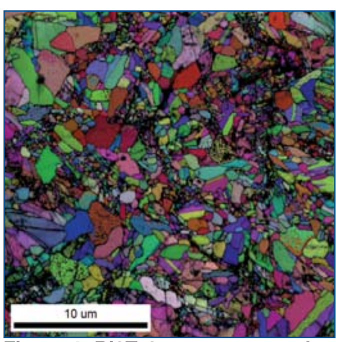

Figure 4: Bi2Te3 nanostructured material, collected with a 15 nm step size.

Accurate measurement of your material

Precision is the measure of how accurately an EBSD system can determine orientation in a sample. This is an extremely important parameter for an EBSD system, especially with modern lightweight and high performance structural materials. The production of these materials often introduces some level of deformation into the material itself and understanding this deformation is the key to controlling both the production process and the resultant material properties.

Figure 5 clearly shows the importance of precision. The image on the left, collected with a precision of 0.1 degrees, shows the true deformation structure of the sample and helps the user to understand the strength, ductility, creep, and fatigue properties of his sample.

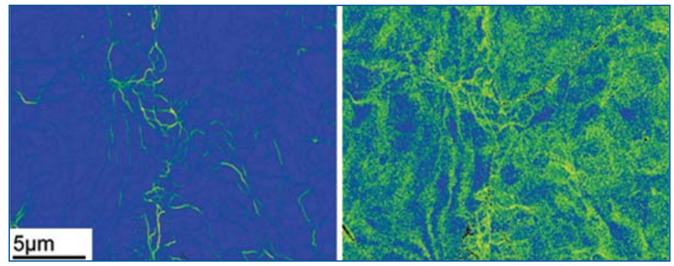

Figure 5: Deformation measurements on an Aluminum sample, with Precision of <0.1 on the left and 0.4 degrees on the right.

The image on the right, collected at a precision of 0.4 degrees, does not have the inherent accuracy to distinguish the true structure from the noise and does not provide a full understanding of the materials properties.

Ease of Use

Fully integrated into TEAM™ EBSD, the Hikari XP benefits from the advanced Smart Features that form the backbone of the TEAM™ Platform. Smart Camera, Smart Background Collection, and Smart Indexing apply the ease-of-use design philosophy of TEAM™ to optimize the capabilities of the Hikari XP camera, making EBSD data collection and analysis straightforward for users at any level.

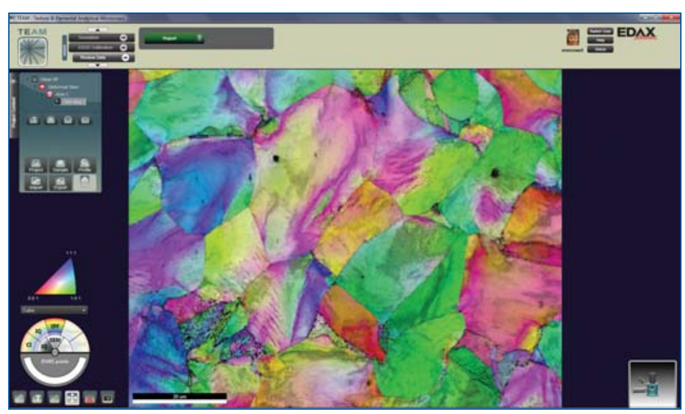

Figure 6: TEAM interface, optimizing camera ease of use.

Conclusion

The Hikari XP excels in all types of EBSD applications and delivers performance without compromise to EDAX customers.

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High Speed EBSD

EBSD Data Collection at 650 Indexed Points Per Second

With the introduction of the Hikari XP camera, which is capable of data collection at very high speeds, good quality large area mapping can be done in a very short time. The Smart features built into TEAM™ EBSD allow for easy collection of Electron Backscatter Diffraction (EBSD) patterns and Orientation Imaging Microscopy (OIM™) maps. The Smart Camera Setup, within the TEAM™ software, automatically optimizes the EBSD camera and background collection, ensuring ease of data collection at the most optimal settings. Combining TEAM™ with the new Hikari XP camera, data collection of 650 indexed points per second (ipps) is now possible without user setup.

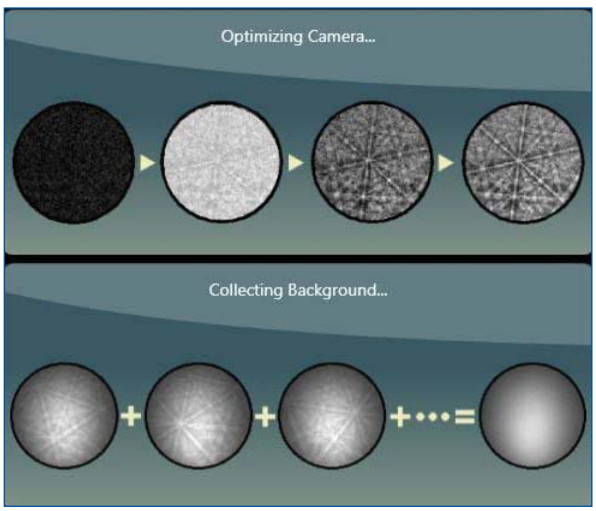

Figure 1: Automatic camera optimization and background reference image collection in TEAM™ EBSD.

Using the OIM™ Data Collection software, the standard procedure for collecting data at 650 ipps involves setting up both the camera instrument console as well as the hough transform. In general, the camera setup requires manual settings of binning, gain, and exposure. Additionally, the Hough transform has multiple variables to be set by the user. Under standard procedures, the magnification must be decreased to capture a background reference image that only contains the intensity distribution with no visible EBSD patterns. After the background image has been collected, it must be subtracted from the original pattern to enhance the illumination of the EBSD bands. Although using a simple background subtraction may suffice, applying enhanced image processing routines will improve the contrast of the EBSD patterns. A combination of background subtraction, dynamic background subtraction with 10 passes of blurring, and normalize intensity histogram, is highly recommended. Once the image processes are applied, the magnification must be returned to the analysis magnification prior to the start of the data collection.

In TEAM™, EBSD maps can be collected at 650 ipps without user setup of the camera, hough settings, or the manual collection of the background reference image. The only user input required is the selection of the Max Speed auto-optimization routine. At the start of the map collection, the camera and hough settings will be automatically set to the optimal values for collecting EBSD data at 650 ipps. TEAM™ automatically decreases the magnification, collects a background reference image, applies image processing routines, and returns the magnification to what was previously set by the user to start data collection. Figure 1 shows the notification windows that appear during automatic setup by TEAM™.

TEAM™ users are not limited by the auto-optimization routines. Any of the camera settings, hough transformation parameters, and background collection can all be accessed via the advanced settings panel. Advanced users may choose to use the auto-optimization routines as a general guideline prior to making finer adjustments that suit their needs. Figure 2 shows a comparison of EBSD maps collected with manual settings and automatic settings on a steel sample.

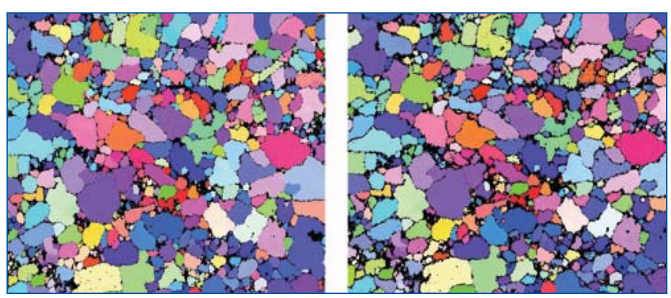

Figure 2: Inverse pole figure map with points having confidence index > 0.1 collected with (left) manual user setup in OIM™ Data Collection and (right) automatic camera setup in TEAM™.

With the new Hikari XP camera, EBSD maps can be collected at much higher data collection rates. Regardless of the experience level of the user, the Smart Camera Setup feature in TEAM™ can quickly assist users to find the most optimal settings for collecting data with minimal amount of time spent on the initial setup.

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Characterization of Metal Thin Films for Microelectronic Interconnects Using the Hikari XP

The Hikari XP is a high performance EBSD camera that offers performance without compromise across the complete range of EBSD applications. The Hikari XP provides high speed throughput for rapid and reliable data collection, high sensitivity for operation at lower beam currents and acceleration voltages for improved spatial resolution, and high precision orientation measurements for a clearer understanding of deformation within materials. Combined with EDAX's TEAM™ software platform, the triplet indexing EBSD pattern analysis method, and the patented Confidence Index metric, the Hikari XP offers the best possible data with the highest indexing success rates in one camera. This application note presents a characterization case study highlighting the benefits of the Hikari XP.

Figure 1 shows combined image quality and orientation maps from data collected from an alloyed aluminum thin film (Al-0.5% Cu) with varying acquisition times and parameters. The EBSD image quality measures changes in EBSD pattern quality and sharpness and provides grain and orientation contrast while the orientation map shows the crystal orientation distribution relative to the surface normal of the thin film using the colored stereographic triangle as a reference. This type of metallic film has been used to manufacture interconnect lines within integrated circuit devices. The relationship between the film texture and microstructure and time to failure has been found to be:

$$MTF = K\left(\frac{S}{\sigma^2}\right)\log\left[\frac{I_{(111)}}{I_{(200)}}\right]^3$$

Where MTF is the mean time to failure, K is a material constant, S is the mean grain size, σ is the standard deviation of the grain size distribution, and I(111) and I(200) are the intensities of the (111) and (200) texture components. This equation indicates that a strong (111) texture and large grains are desirable.

EBSD is an ideal tool for measuring both the texture and grain size of these films. With the Hikari XP, EBSD patterns were collected and indexed at 650 points per second. Table 1 summarizes the results from scans collected with varying sampling strategies, with the scan numbers corresponding to the labeling within Figure 1.

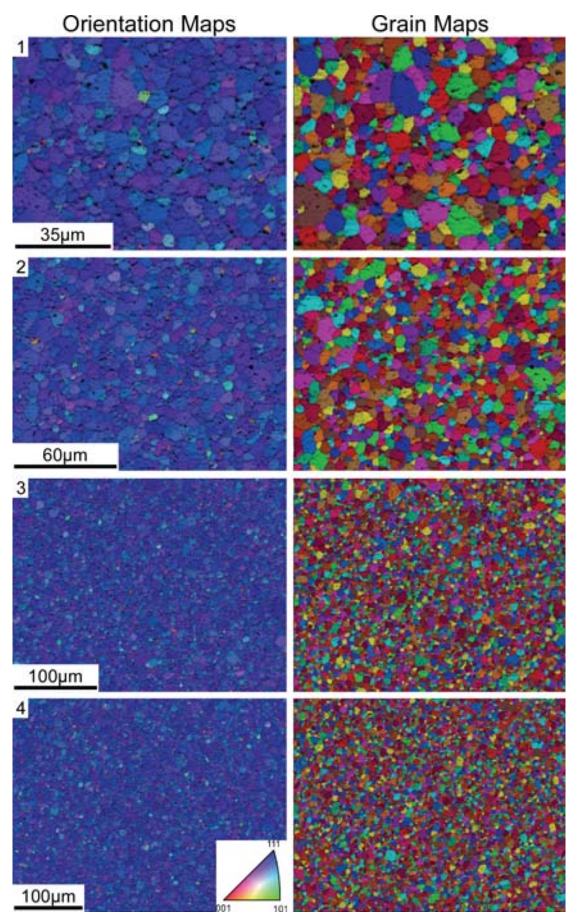

Figure 1: Orientation and grain maps for aluminum film data acquired with varying sampling strategies.

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Scan	Area X (μm) x Y(μm)	Step Size (nm)	Time (min)	# of Grains	Ave Grain Size (μm)	(1 11) Texture MTR
1	100 x 78	500	1	463	3.75	13.4
2	160 x 125	350	5	1086	3.96	13.8
3	330 x 258	700	5	4741	4.14	13.3
4	400 x 312	250	60	7237	3.97	13.6

Table 1: Results from scans collected at 650 indexed points per second from aluminum thin film.

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Characterization of Metal Thin Films for Microelectronic Interconnects Using the Hikari XP (Cont'd. from Pg. 4)

It is important to note that even with the 650 indexing points per second acquisition rate, the indexing rate was greater than 99% for each of the scans. This unparalleled performance combination of both speed and accuracy is obtained by combining the throughput of the Hikari XP camera with the robustness of the EBSD triplet indexing approach and the unique and patented Confidence Index, which allows users to determine not only if a given point has produced an orientation solution, but whether that solution is a correct solution.

With an acquisition speed of 650 indexing points per second, the data collected in Scan 1 is able to give a fast and accurate quantitative characterization of the aluminum microstructure in one minute. When selecting a scan strategy, the area selected determines the total number of grains sampled while the step size determines the number of points per grain sampled. The parameters for Scan 1 were selected to obtain a balanced overview of the microstructure in one minute. The parameters for Scan 2 were selected to increase the points per grain while the parameters for Scan 3 were selected to increase the number of grains sampled. Scans 2 and 3 were both five minute scans. The parameters for Scan 4 were selected to increase both the points per grain and the number of grains samples by increasing the collection time to one hour. For the 4 scans, the standard deviation of the grain size measurements was ≈2.5%, which is smaller than the 3.6% deviation obtained when scanning 10 different areas of the sample under identical collection conditions. Similar variation results were observed for the (111) texture strength, which is presented in units of Multiple Times Random (MTR). This data indicates that a statistically reliable characterization of the aluminum film has been obtained in one minute using the Hikari XP.

As integrated circuits (IC) device dimensions shrink, copper has been increasingly implemented as the interconnection metal due to its higher conductivity. Copper is also used in three-dimensional integrated circuits using through silicon vias (TSVs). As with aluminum, grain boundaries act as diffusional paths aiding electromigration failure. However with copper there are a significant fraction of coherent twin boundaries within the microstructure that have diffusion rates lower than random high-angle grain boundaries. Increasing the fraction of twin boundaries through film deposition and thermal processing reduces the unfavorable diffusional paths and improves mean time to failure. EBSD is well suited to measure a large number of grain boundaries, and classify them as either helpful twin boundaries or detrimental random high-angle grain boundaries. Figure 2 shows an EBSD grain map, where twins are included or excluded during the grain calculation along with an orientation map for data collected for five minute and for sixty minutes. The grain size of the copper film (≈1.4 μm) with twin boundaries ignored as grain boundaries during grain determination is significantly larger than the grain size when twin boundaries are included (≈500 nm). Due to a small step size (65 nm) being used to resolve the small grains, the five minute data is only able to detect approximately 80 twin-removed grains. The one hour data is able to provide better grain statistics (≈ 1200 grains) with sufficient resolution to determine the twin-included grains as well.

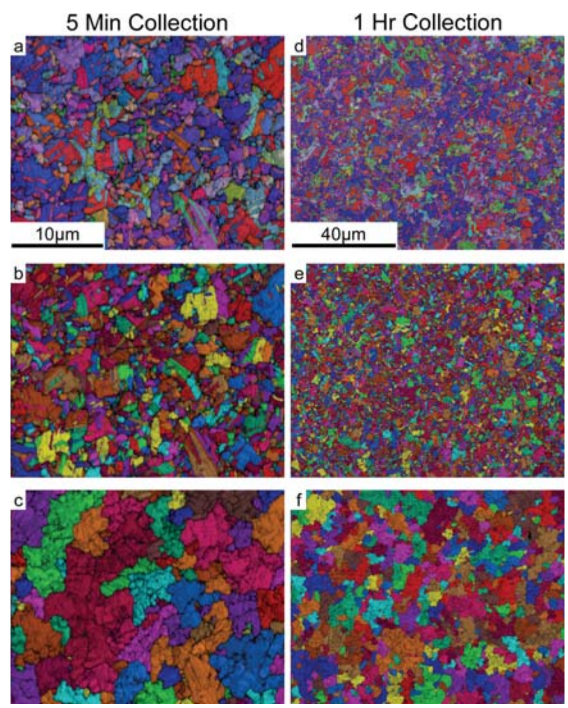

Figure 2: Orientation maps (a & d), grain maps including twins (b & e), and grain maps excluding twins (c & f) for copper film collected for five minutes and one hour.

The Hikari XP Camera and TEAM™ EBSD software can provide near real time microstructural data that can be used for both process development and quality control. EBSD has the ability to measure the grain size that predicts performance and can help optimize processing conditions to improve device lifetime.

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TRAINING AND EVENTS

World-Wide Events

July 29 - August 2, 2012	Microscopy & Microanalysis (M&M)	Phoenix, AZ
August 12-17, 2012	International Materials Research Congress (IMRC)	Cancun, Mexico
September 5-7, 2012	Japan Analytical Scientific Instruments Show (JASIS)	Makuhari Messe, Japan
September 16-21, 2012	European Microscopy Congress (EMC)	Manchester, United Kingdom
September 25-28, 2012	Het Instrument	Amsterdam

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

2012 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 systems, we organize a number of Operator Courses at the EDAX facilities in North America; Tilburg, NL, Wiesbaden, Germany, Japan, and China.

***Please visit our website **www.edax.com/support/training/index.aspx** for additional information on our training classes.

Europe

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

Tilburg

EDS Microanalysis:

- ◆ September 13-14, 2012
- ◆ October 2-4, 2012
- ◆ November 8-9, 2012
- ◆ November 20-22, 2012

EBSD:

- ◆ September 10-12, 2012
- ◆ November 12-14, 2012

WDS LEXS:

- ◆ October 23-25, 2012

Wiesbaden

EDS Microanalysis:

- ◆ TBD

Pegasus:
(EDS/EBSD)

- ◆ November 5-9, 2012

EDS (TEAM™)
& WDS TEXS

- ◆ TBD

Orbis:
Course & Workshop
Presented in English

- ◆ October 23-25, 2012

Japan

EDS Microanalysis:

- ◆ July 12-13 Osaka
- ◆ October 11-12 Tokyo
- ◆ November 8-9 Osaka

EBSD:

- ◆ August, 2012 Tokyo
- ◆ December, 2012 Tokyo

China

EDS:

- ◆ September 4-6, 2012

EBSD:

- ◆ September 11-13, 2012

Particle Analysis:

- ◆ December 4-6, 2012

North America

EDS Microanalysis:

- ◆ July 10-12 Draper, UT
- ◆ September 25-27 Mahwah, NJ

EBSD:

- ◆ October 23-25 Mahwah, NJ

Pegasus:
(EDS/EBSD)

- ◆ TBD Mahwah, NJ

EDS & WDS Neptune:

- ◆ November 13-15 Mahwah, NJ

Micro-XRF:

- ◆ October 2-4 Mahwah, NJ

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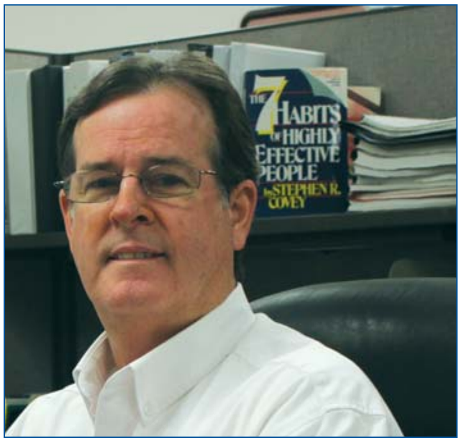
EMPLOYEE SPOTLIGHT



Stephen Mann began his career in the US Navy. His assignment was Aviation Fire Control Technician with Attack Squadron 176, serving several tours in Europe and the Middle East. He completed his naval career as an instructor.

In 1985, Stephen joined Philips Electronics as Technical Specialist for X-ray Security Screening products. In 1987, when the EDAX business unit moved from Chicago, IL to Mahwah, NJ, he was assigned the position of Supply Center Service Manager for EDAX.

For over 23 years, Stephen has been on the frontline of Customer Support throughout the evolution of EDAX's technology. Currently, in the role of Technical Specialist, Stephen is applying his experience and insight to providing support for EDAX's worldwide Sales and Service Team.

Stephen's hobbies are skiing, volleyball, softball, and spending time with family. His wife Karen is a Special Education teacher for over 25 years. His son Shelby is training at the Police Academy in Colorado Springs, CO and daughter Jessica is attending State University of New York.

Harry Verhulst joined EDAX in August 2005 as an X-ray Microanalysis Product Application Specialist. He is located in our EDAX Tilburg office in the Netherlands.

Harry finished a two year post-graduate education at Technical University of Eindhoven. He then earned a Masters degree in Chemistry from the University of Nijmegen.

As an application engineer, Harry is responsible for supporting EDS and WDS customers. He is also responsible for training and software testing, for performing demos, for service issues, and for assisting with installations. Harry has installed customer systems in places including Melbourne, India, and all over Europe.

Before joining EDAX, Harry worked for approximately 10 years in the semiconductor industry as an application engineer, traveling around the globe.

Harry, his wife Yvonne, their three daughters, Danielle (16), Suzanne (14), and Eline (10) live in the city of Bergen op Zoom, in the southern part of the Netherlands. They also have a 'Kooikerhondje' or Kooiker Hound, a small spaniel-type breed of dog, of Dutch ancestry named Indy.

In Harry's spare time, he likes to exercise, work in his garden, and enjoy a good book or movie.

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EDAX NEWS

New EDAX User Group on LinkedIn

At EDAX, we love helping our customers push the limits of science to solve challenging materials problems. Join the EDAX User Group to start discussions with the team, get feedback and hear about upcoming events and new products at EDAX. Go to http://linkd.in/L4JN1R to sign up!

Join EDAX in Booth #646 at M&M 2012 in Phoenix, AZ from July 29th – August 2nd

M&M is the premier meeting for scientists, technologists, and students who use microscopy and microanalysis in their research. The EDAX team will be offering participants the chance to schedule sample analysis demonstrations and see our TEAM™ Pegasus platform in action. To schedule a demo and to view our show schedule, please visit EDAX.com.

Join us at our booth on Tuesday, July 31st at 2PM to help celebrate EDAX's 50th Anniversary.

Join us to learn more about our new products to be unveiled at the show.

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advanced microanalysis solutions

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