XPRESS

ENHANCING EFFICIENCY
BY SHARING **KNOWLEDGE**

Malvern Panalytical
a **spectris** company

AIMING FOR SUSTAINABILITY

Tanneke Reinders
Vice President Marketing,
Malvern Panalytical

Dear reader,

The publication of this edition of XPress coincides with the arrival of Spring in the Northern Hemisphere, which is where I spend most of my time. It's always encouraging to see nature's revival and the start of a new growing season. At the same time, however, I am increasingly aware of the need for sustainable growth to preserve our planet for future generations. The production of food for the ever-growing population has a significant impact on our environment. It's vital that we find a good balance between a cost-efficient but sustainable production process which can provide sufficient food of good quality. In our article 'From field to plate', we show how Malvern Panalytical solutions help achieve this goal throughout the food production chain.

Another aspect of sustainability is the development of new technologies to protect the environment and our natural resources. The power conversion market is an important player in this field, and we are proud to contribute to its growth by presenting a new software suite for the analysis of epitaxial layered structures, used in applications such as the development of battery chargers and photovoltaics.

Sustainability, respect for the environment and for each other are only a few aspects of our Code of Business Ethics (CoBE). We know how important it is for Malvern Panalytical
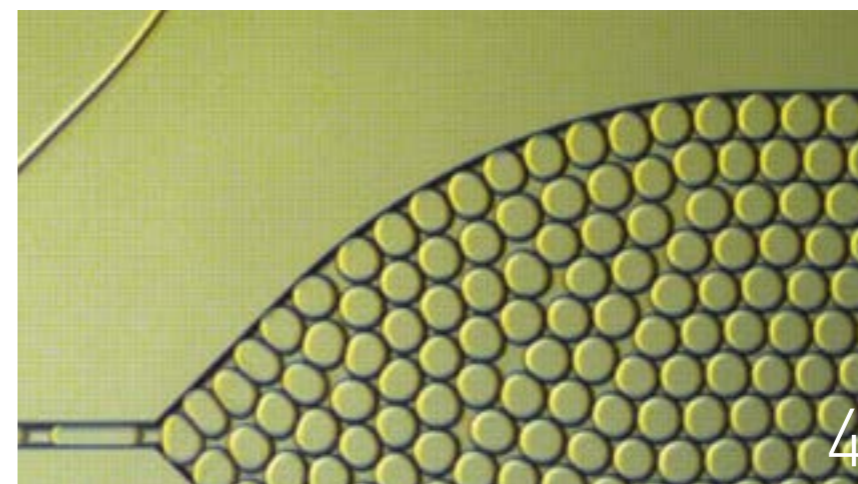
customers that we always do business the right way – every time, without exception. In this issue, Tom Mulder, our Vice President - Legal, explains the underlying principles of Malvern Panalytical's Ethics Program. By sharing his view on our CoBE, Tom creates insight into a topic which may not have widespread recognition. This aligns with another of Malvern Panalytical's priorities: to acquire and share knowledge and best practice – a great example of this collaborative mindset is on display at user meetings such as our Ore and Minerals Analysis workshops.

We aim to help our customers stay at the forefront of technological development. In the last few issues of XPress we've described our predecessors' groundbreaking roles in the emergence and development of modern materials analysis. In this issue, we share the story of our PANalytical years, one of the crucial stages in our evolution into Malvern Panalytical.
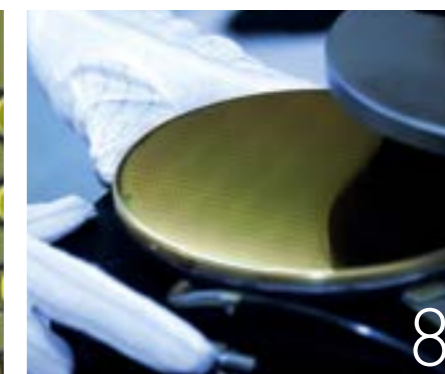
I hope you enjoy this issue, and as always, encourage your feedback via info@malvernpanalytical.com.

With kind regards,
Tanneke Reinders

2019 – INTERNATIONAL YEAR OF THE **PERIODIC TABLE OF THE ELEMENTS**

The Periodic Table of Chemical Elements is one of the most significant achievements in science, capturing the essence not only of chemistry, but also of physics and biology. This unique tool enables scientists to predict the appearance and properties of matter on Earth and elsewhere in the Universe.

1869 is recognized as the year of discovery of the Periodic System by Dmitri Mendeleev, so in 2019 we celebrate the 150th anniversary of the Periodic Table of Chemical Elements. In addition, the United Nations General Assembly and UNESCO have proclaimed 2019 to be the 'International Year of the Periodic Table of Chemical Elements (IYPT2019)'. This year also marks the Centenary of IUPAC, the

International Union of Pure and Applied Chemistry, a world authority on chemical nomenclature and terminology, including the naming of new elements in the periodic table, on standardized methods for measurement, on atomic weights and many other critically-evaluated data. The events surrounding IUPAC100 and IYPT 2019 should enhance public understanding and appreciation of the Periodic Table and chemistry.

Stay informed about activities around IYPT2019 and IUPAC100 on www.iypt2019.org and on iupac.org/100

IN THIS ISSUE
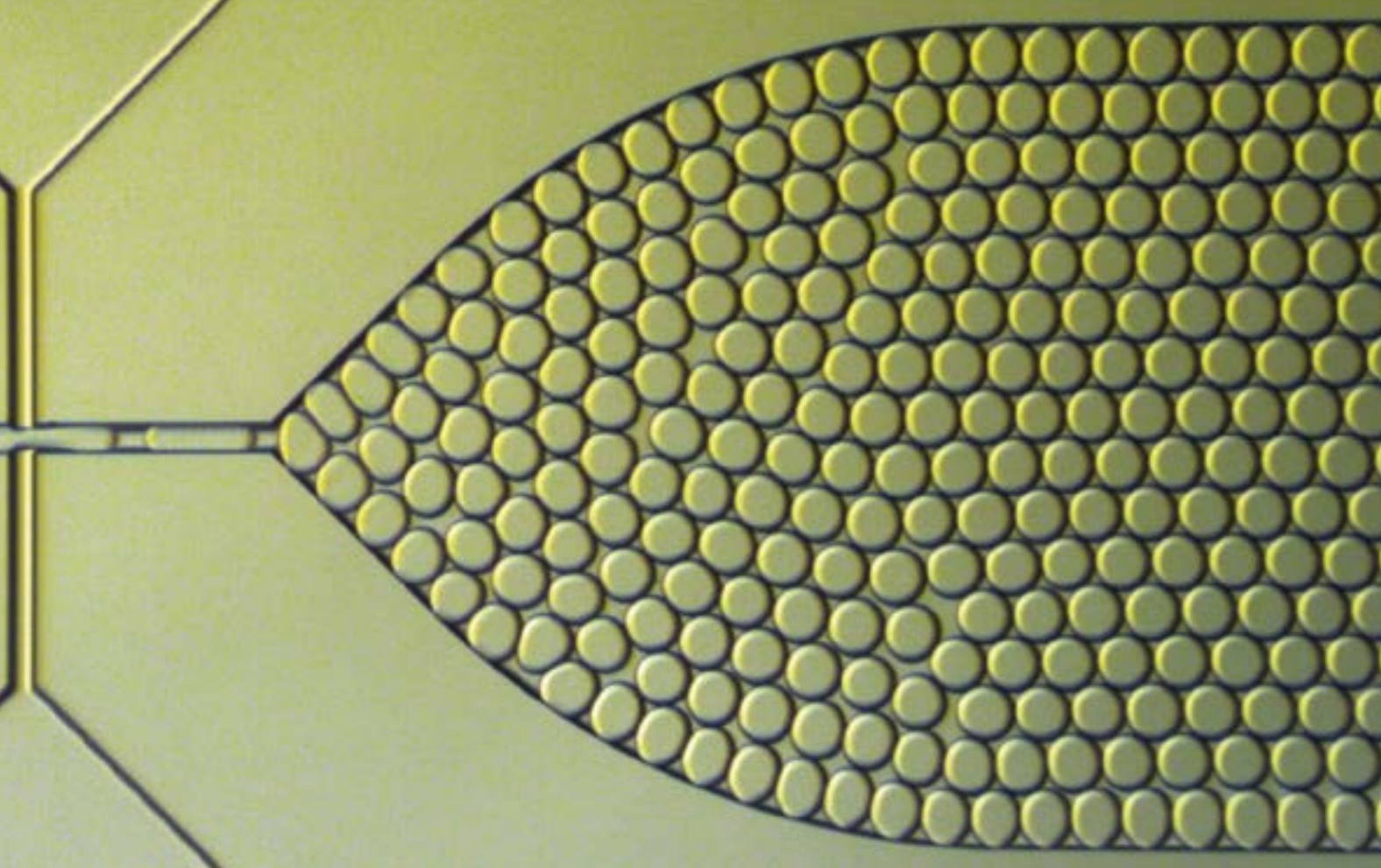
Highly monodisperse 2.5 µm PLGA particles produced using 14 µm Dolomite Microfluidics Small Droplet Chip

DOLOMITE MICROFLUIDICS SPEEDS AND SIMPLIFIES ITS NANOMATERIAL DEVELOPMENT WORKFLOW

Dolomite Microfluidics specializes in the production of high-performance nano- and microparticles which are precision-engineered for advanced functionality and encapsulation. These materials have unique properties determined by their size, shape and architecture, which enable them to be used as specialized research tools within biomedicine, diagnostic imaging and industrial catalysis. At Dolomite Microfluidics, state-of-the-art automated continuous flow processing and droplet microfluidics are used to ensure very monodisperse particles with high batch-to-batch consistency. This is a feature which discriminates the company from other manufacturers and optimizes their products' performance, whilst allowing their customers to generate high-quality, reliable data. Pavel Abdulkin is the Head of Chemistry at Dolomite Microfluidics and is responsible for developing and growing the company's particle engineering business.

Control and optimization

The team at Dolomite Microfluidics designs their materials for peak performance, and it is their strict control over particle size which enables them to optimize size-related functionalities such as plasmon resonance, fluorescence efficiency, and emission color. They depend on technologies which can accurately characterize these 5 nm – 500 µm particles, ensuring that their size and morphology both lie within tightly-controlled limits. Their go-to technique to manage these

requirements was transmission electron microscopy (TEM), a reliable yet expensive, time-consuming and therefore low-throughput process which became a limiting factor in their production efficiency. In addition, TEM is only capable of measuring a small proportion of each sample during each analysis, so it often needed support from an orthogonal technique in order to verify the state of the entire sample.

"Our sample throughput has increased dramatically."

A better, faster way of working

Pavel recalls, "On meeting Malvern Panalytical, we learned that they

were interested in understanding how a new solution they were developing, the Zetasizer Ultra, performed in a working laboratory environment. We used the instrument to gather data on a wide range of our sample types, whilst providing feedback on both the system and its software."

Pavel Abdulkin
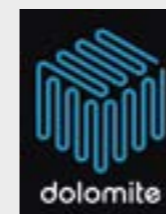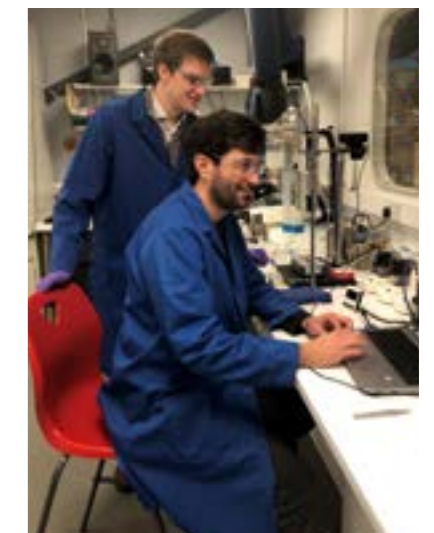Head of Chemistry at Dolomite Microfluidics

The Dolomite Microfluidics team found the Zetasizer Ultra trivial to set up in their lab: most of their scientists were up and running with the new system within one day. Pavel explains: "We are now able to characterize our research samples using Dynamic Light Scattering (DLS) much more rapidly than we could with TEM – we are looking at a measurement and data analysis time of **less than 5 minutes per sample,** compared to the 4 hours for measurement alone that we were used to with TEM. And what's really great is that **there's no delay between synthesis and measuring the samples**. Using the Zetasizer Ultra, we can analyze the product immediately after it's made (or even analyze samples on the fly during synthesis!) to better understand the way our particles form and rapidly see if the product meets our Quality Control specifications."

Pavel continues, "We benchmarked our sample analysis using the Zetasizer Ultra against previous TEM analysis and proved that the new DLS data was reliable and accurate. This gave us confidence in the ability of the Zetasizer Ultra to measure new samples without needing TEM data as a 'safety net'. Data is so quick to acquire, easy to analyze, and is representative of the whole sample, giving us true particle size distributions. Using Multi-Angle DLS (MADLS®) in particular, we can be completely sure that we don't miss measuring a single particle, ensuring the monodispersity of our products."

"By using the Zetasizer Ultra to test our samples we were able to significantly reduce the amount of TEM that we perform, which has enabled us to streamline both our R&D process and

our Quality Control, and **significantly reduce our analytical costs**. Our sample throughput has increased dramatically – we are now looking at around one month per development cycle, as opposed to the 12 months this originally required."

Dolomite Microfluidics found that the Zetasizer Ultra uniquely and clearly met their analytical requirements. Pavel adds, "The team at Malvern Panalytical have been fantastic collaborators, and communication with them has always been easy, with quick, detailed responses from all individuals involved. The support we have received has been excellent, as well as visits to install updates and give refresher training, which reminded us of additional functionality we could be using. We hope to continue our collaborative relationship in the future."

Dolomite Microfluidics, based in Royston, UK, is a brand of Blacktrace Holdings Ltd, a company which develops and manufactures groundbreaking technologies for applications in biology, chemistry, microfluidics and nanomaterials.

Dolomite Microfluidics specializes in the production of high-performance nano- and microparticles which are precision-engineered for advanced functionality and encapsulation.

BOOSTING EFFICIENCY WITH BETTER
PROCESS MONITORING AND AUTOMATION

With decreasing resources of reliable quality, industries such as the cement and mining industries are dealing with the increased variability of incoming raw materials. This is mostly caused by less homogeneous ore bodies, use of fringe materials from limestone quarries or by changing alternative fuels. In these and more cases, an efficient control of the production process calls for the use of increasingly advanced analytical methods with short feedback loops on a 24/7 basis.

In order te deliver accurate and reliable results, such analytical methods require a proper, highly reproducible sample preparation. Human sample preparation, however, is often operator-dependent, resulting in inconsistencies per shift. Automation of sample preparation and subsequent measurement and analysis results in a constant feedback loop to the process. This way human errors are minimized, and superior consistency of the analytical results is assured. Additional advantages are reduction of lab personnel who can concentrate on other tasks, and the reduction of chances for mistakes or accidents – the automated installation takes care of the entire analytical process.

But which analyses are most suited to solving your analytical questions? And how could these be automated? Malvern Panalytical offers numerous solutions for elemental, structural, particle size and shape analysis, often with options for automated sample preparation, loading, and analysis. Our instruments come with well-defined hardware- and software interfaces, ready to be integrated in an automated solution. Our experts can advise you on the most suitable sample preparation for your process, on efficient data collection and analysis strategies. Or you discuss your challenge with our Automation Solution Group, who delivers complete turn-key automated solutions for almost any challenge, small or large, containing Malvern Panalytical or third-party sensors and tools.

The heart of such an installation is the analytical instrument, for example an X-ray fluorescence (XRF) or X-ray diffraction (XRD) spectrometer or a particle size analyzer. The latest addition to our solutions portfolio is Aeris, the first automatable benchtop XRD spectrometer. Its small footprint, high data quality and ease of use make it an ideal tool to characterize the mineralogical properties of materials in an industrial process. The examples below are meant to give you an impression of possible automated combinations and suggest how these can solve your challenges. Our Automation Solutions Group is happy to discuss new problems and propose solutions.

AUTOMATION EXAMPLES
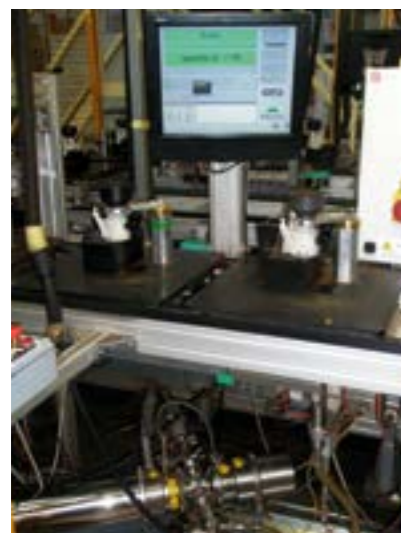
Quality control for a coffee producer

De'Longhi, a producer of coffee makers, manufactures and tests all basic units prior to assembly of the finished systems. For assembly line testing of the coffee grinder the company chose Malvern Panalytical's Insitec real-time particle size analyzer, which was installed at a work station on one of the assembly lines, directly at the bench to which the grinder is delivered for testing. Fresh coffee beans are poured into the grinder activating the testing sequence.

The particle size distribution data of the sample is presented in real- time on the screen towards the back of the workstation, indicating pass(the grinder meets performance goals) or fail, and what corrective actions must be taken. The solution allows fast on-line testing of product quality, avoiding delays in production and minimizing the risk of errors.

Typical solutions for the cement industry

Cement producers often require crystallographic information as well as elemental analysis to ensure product compliance.

For this purpose, the combination of automatic sample preparation, X-ray fluorescence spectrometer and an X-ray diffractometer, all connected by either a belt or a robot, is commonly used in modern cement plants. This setup allows for optimal sample preparation for XRF and/or XRD with constant, operator-independent quality. Our turnkey solution is equipped with software that takes care of the entire process and the results' output.

Particle size is a critical parameter that has direct impact on product quality. An Insitec real-time particle size analyzer installed directly after the grinder provides a complete particle size distribution of the product every few seconds. These data are converted into a 10-minute rolling average for use by the control system, which initiates corrective actions when necessary.

These and comparable solutions enable cement producers to safeguard the quality of their product while avoiding unnecessary costs associated with excess processing time.

Automated sample preparation

In this example, a large producer of zeolites needs to check the readiness of a certain step in a complex batch production process.

At fixed intervals, samples are taken from the reactor and pipetted into a sample holder, which is transported into a small oven by a conveyor belt. Heating the sample for a set amount of time evaporates the liquid, leaving behind the dry matter. This is subsequently analyzed by X-ray diffraction to reveal information about the completeness of the reactions and the achieved crystallinity.

The company avoids costs associated with excess reaction time and heating energy by closely monitoring the process within the reactor.

Automation in the mining industry

Yara, a large Finnish mining company (X'Press 2/2016), has chosen for a customized automation which monitors their mining and production processes. Samples are processed entirely automatically, with robots taking care of sample transport between mills, presses, bead makers, XRD and XRF instruments, and the cleaning station. Malvern Panalytical's proprietary software evaluates the data and seamlessly communicates the results to Yara's laboratory information management system (LIMS).

Due to the fast and extremely reliable results, Yara can make decisions about its processes much faster, resulting in very efficient process control.
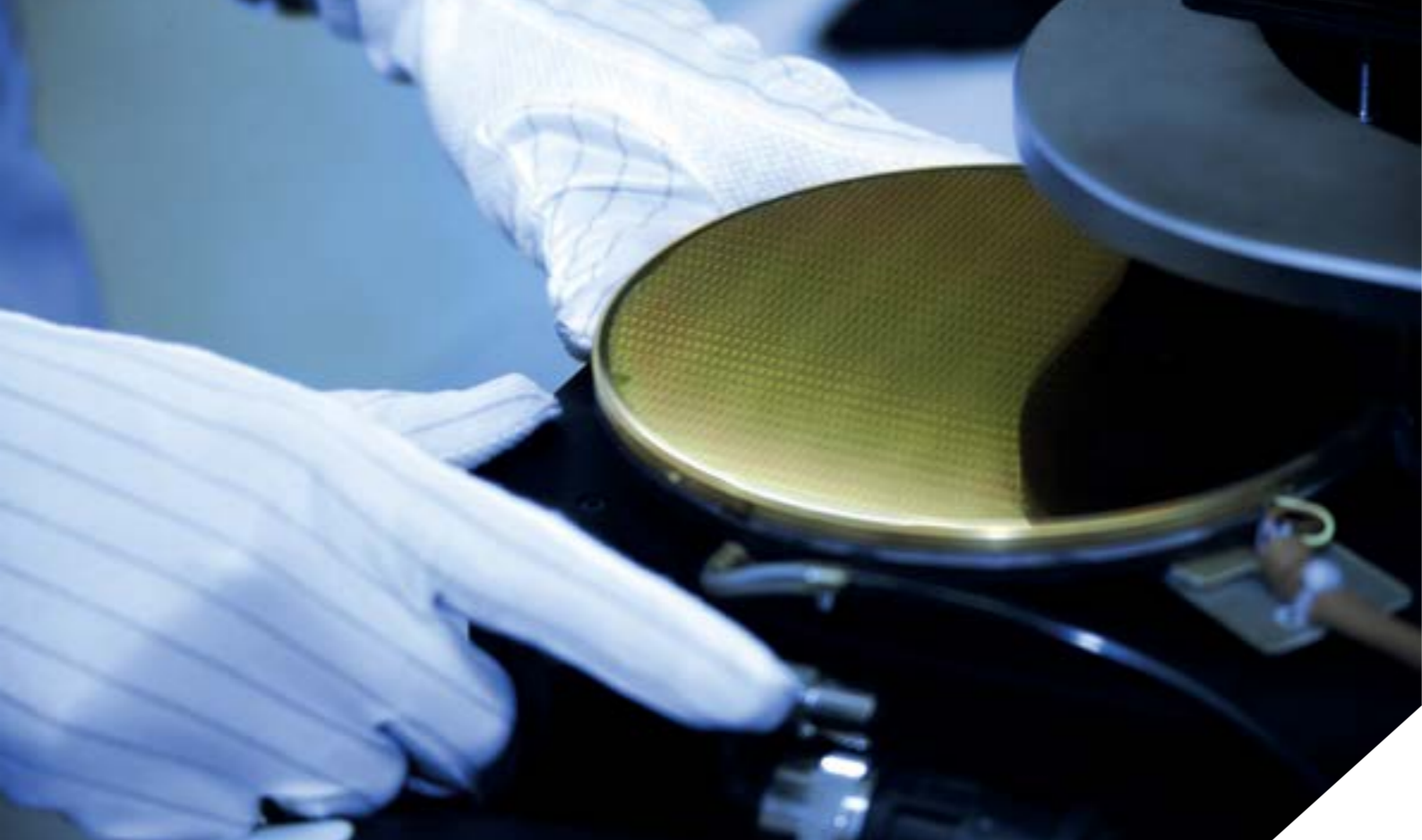
# FACILITATING AUTOMATIC ANALYSIS OF THIN-FILM STRUCTURES

Advanced analysis of GaN-on-Si high electron mobility transistors (HEMTs)

GaN-on-Si technology has evolved from extensive research activities and is now entering global large-volume production by a broad range of suppliers. Automated metrology solutions for controlling and optimizing the production of this kind of epitaxial wafer are now in high demand.

Gallium nitride (GaN), a binary III/V semiconductor, and related compounds are now widely used in the production of semiconductor power devices and high brightness light-emitting diodes (LEDs). GaN-based high electron mobility transistors (HEMT) is the most promising technology for high-power, high-efficiency devices in many applications. Here, GaN is epitaxially grown on a variety of substrates; for example GaN-on-Si, which is formed by thin-layered GaN-based stacks on silicon (Si) substrates which are relatively cheap and are available in diameters up to 300 mm.

One application of GaN-on-Si is in power devices such as battery chargers, smartphones, computers, servers, automotive, lighting systems and photovoltaics. Such devices based on GaN are therefore anticipated to play a key role in the emerging power conversion market.

Production of GaN-on-Si is based on the epitaxial growth of multilayer GaN heterostructures on Si substrates using metal-organic chemical vapor deposition (MOCVD). These devices contain epitaxial layered structures of increasing complexity.
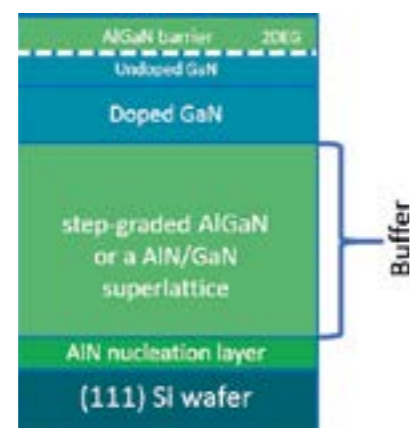
Cross-section of a typical epitaxial layer structure used for the manufacture of GaN-on-Si high electron mobility transistors (HEMTs)

The quality of the AlGaN barrier and the underlying GaN layer which form the 2DEG are crucial for the device's performance and reliability. These depend on the quality of the thick GaN layer grown on the buffer structure. Thorough analysis of the individual layers of these multilayer structures is a challenge for existing characterization methods.

"AMASS with new comprehensive functionality can be used to determine the uniformity of all parameters on a wafer. This is essential for optimizing the production of epitaxial wafers."

Joachim Woitok
Product Manager XRD thin films at Malvern Panalytical

X-ray metrology

High-resolution X-ray diffraction is an established and powerful tool for the non-destructive characterization of heteroepitaxial structures. It is routinely employed for both materials research and quality control in production. X-ray diffraction patterns provide information about composition and uniformity, layer thickness, strain relaxation, crystalline perfection and much more.

Maps around reciprocal lattice spots (RSM) can reveal additional information beyond that provided by single line scans such as high-resolution rocking curves. RSMs are typically used to aid the interpretation of peak displacement, peak broadening or peak overlap. They have, however, not often been used because they are considered too time-consuming to collect and analyze.

However, recent advances in X-ray area detector technology combined with smart positioning algorithms and data processing now allow recording of RSMs at faster timescales as rocking curves. These high-speed measurements find applications in the characterization of all types of crystalline advanced materials. In the example below, we can see how RSMs can be used to characterize GaN-on-Si HEMTs.
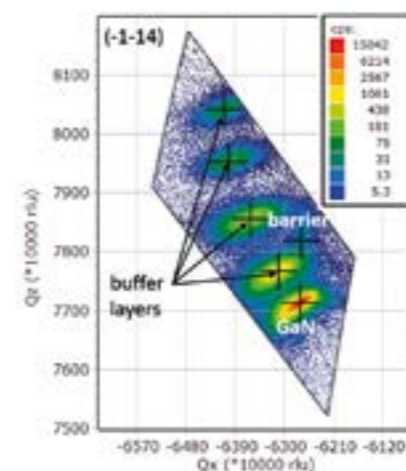
Ultra-fast RSM collected in only 30 seconds on an AlGaN/ GaN HEMT structure on Si (111)

Analysis of HEMT structures

Determination of the composition and thickness of the barrier layer of a GaN-based HEMT is a two-step process:

Evaluation of the RSM around the (-1 -1 4) GaN reflection reveals the composition and relaxation values of the buffer layers and of the AlGaN barrier. Our recently introduced AMASS (Advanced Materials Analysis and Simulation Software) automatically searches and labels peak positions and determines Al composition and relaxation of the barrier layer. The same applies for the buffer layer peaks.

While the RSM cannot provide information about the thickness of the thin topmost layers, this information is accessible from full-pattern fitting of rocking curves of the symmetrical (00l) reflections. Due to heavy overlap with the buffer peak positions, the thin barrier layer cannot be resolved, but its thickness fringes are present. AMASS's fitting option keeps the previously determined composition and relaxation values fixed while fitting the thickness values of a corresponding sample model. The described two-step workflow can be fully automated in AMASS.

"AMASS is our new thin film analysis toolbox. It covers and expands the functionality of our former Epitaxy and X'Pert Reflectivity software. Additionally, it comes with comprehensive new functionality to display, analyze, simulate and fit X-ray data from thin-film layered structures," says Dr. Joachim Woitok, Malvern Panalytical Product Manager XRD thin films. "Results of multiple data sets collected on different X, Y wafer positions can be used to determine the uniformity of all parameters on a wafer. AMASS takes care of the necessary steps."

For more information about the applications of AMASS, a recorded webinar is available. Why not check out what this software offers for your analytical problems with layered structures!
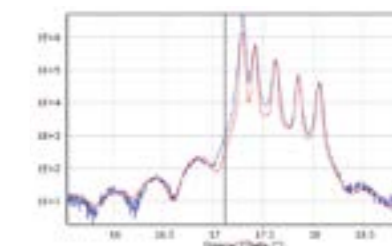
Fitting result (red curve) on a (002) rocking curve of a GaN based HEMT structure revealing the thickness values of the barrier and related layers
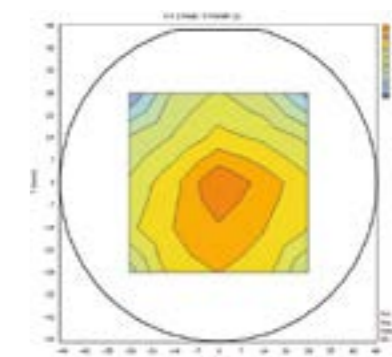
Wafer map result showing the distribution of a parameter value in the center part of a 100 mm epi wafer.

Glossary	
GaN	gallium nitride
AlGaN	aluminium gallium nitride
GaN-on-Si	gallium nitride on silicon
2DEG	'two-dimensional electron gas'
HEMT	high electron mobility transistors
RSM	reciprocal space map

THE HISTORY OF
X-RAY TECHNOLOGY
2002- 2017
A SIX-PART SERIES

In the 1990s, Royal Philips Electronics went through a restructuring program to bring the company's focus back to its core activities. Several business units were privatized or sold to other companies, and as a result the Philips Business Electronics division was dismantled. As one of the last (but not least) offshoots of the Philips family of scientific instrumentation companies, Philips Analytical was sold and continued under a new name.

1895 - 1917

1917 - 1945

1945- 1972

1972 - 2002

2002 - 2017

2017 - ...

PANALYTICAL – A SPECTRIS COMPANY

A new name in the market
On September 18, 2002, Philips sold its analytical X-ray business to Spectris plc, a leading supplier of productivity-enhancing instrumentation and controls, based in the United Kingdom. According to Hans Nilsson, CEO of Spectris in 2002, Philips Analytical's market-leading X-ray based technologies complemented Spectris' existing instrumentation business and provided valuable experience in markets such as materials research and life sciences. Philips Analytical continued its operations as PANalytical, a new name that "stresses both the universal nature of X-rays as an analytical tool, and our worldwide operation," said CEO Peter van Velzen in X'Press 3/2002.

The new PANalytical logo symbolized the principle of the company's main analytical X-ray technologies: an incident X-ray beam that either generates fluorescent radiation or is diffracted by the crystalline sample.

A brand-new tube factory in Eindhoven
Philips' first X-ray tubes were produced in 1918 in a workshop within the Philips Research Laboratories. In 1972, Philips opened a dedicated analytical X-ray tube factory in a suburb of Eindhoven (see XPress 3/2018). Driven by the continuous expansion of the

business and the increasing demand for more sophisticated production technologies, PANalytical built a world-class, state-of-the-art factory for analytical X-ray tubes, that allowed

the company to optimize its operational effectiveness and efficiency. The new factory, located just a few meters from the old one, started production on August 8, 2011.

A new generation of analytical X-ray systems
PANalytical continued its pioneering research and development in the field of X-ray analytical solutions, resulting in the launches of successors to its renowned instrument families, X'Pert and Axios.

2010 saw the release of Empyrean, the new multipurpose X-ray diffraction system. This new platform was unique in its ability to analyze all sample types, from powders and thin films to nanomaterials and 3D objects on a single instrument. Using the new PIXcel[3D] detector as a CT scanner allowed non-destructive analysis of e.g. pharmaceutical formulations, electronic components and geological and archeological samples.

In 2015, the Zetium X-ray fluorescence (XRF) spectrometer was introduced to the market. The new system was built upon our long-standing experience in developing and manufacturing advanced X-ray systems for elemental analysis. Zetium combines up to three complementary techniques on one platform and provides elemental excellence to users in a wide range of

materials analysis laboratories and industries, ranging from minerals and metals to polymers and petrochemicals.

High-resolution X-ray diffraction
In the 1980s and 1990s, X-ray diffraction entered the semiconductor world as an analytical tool for high-resolution analysis of almost perfect thin-film structures. In 2004, PANalytical introduced the X'Pert PRO MRD XL for X-ray metrology in advanced materials industries. Based on the proven concept of the X'Pert PRO MRD, the new system provided automated loading and analysis of wafers of up to 300 mm diameter, making it a suitable analytical tool for semiconductor production.

With the introduction of the X'Pert Epitaxy and Smoothfit software for automated simulation and fitting of X-ray rocking curves, analysis of measured scans became a single-

button operation. Both programs have recently been combined in the new AMASS software (see p. 8-9).

Expansion of the business
PANalytical widened its presence in the scientific and industrial markets for materials analysis by integrating high-tech companies ASD and Claisse.

Analytical Spectral Devices Inc. (ASD) develops and manufactures near-infrared (NIR) instrumentation solutions and application expertise. Founded in 1990, it was acquired by Spectris on November 26, 2012. The success of ASD in the markets for remote sensing and mining exploration complemented PANalytical's offerings by adding a new contiguous product line with portable, handheld, benchtop and online products.

Claisse, global market leader in inorganic sample preparation by fusion for XRF, ICP, AA and wet- chemical analysis, was founded in 1976 in Québec, Canada, and acquired by Spectris on June 18, 2014. Claisse produces both instruments and consumables, and offers services and expertise for the reproducible preparation of samples by fusion. This eliminates mineralogy and particle size effects and is a prerequisite for achieving precise elemental analysis using Malvern Panalytical's instruments.

ELEMENTAL ANALYSIS
IN- AND OUTSIDE THE LAB:
THE NEXT GENERATION OF EPSILON 1

Do you make products of consistent and reproducible quality, which need a screening before delivery? Then you might benefit from fast and reliable elemental analysis of your products close to your production line. The next generation of Epsilon 1 spectrometers could be the solution you have been looking for!

Epsilon 1 is Malvern Panalytical's small and powerful X-ray fluorescence (XRF) benchtop spectrometer, providing accurate, fast and reproducible elemental analysis for many industry needs. Due to the comprehensive update the renowned system is now available with greater flexibility and precision than ever before. From the outside, the new Epsilon 1 is still as compact as its proven predecessor; with a brighter touchscreen for even **easier operation**. On the inside, however, the changes are a lot more comprehensive. The higher-power X-ray tube and the new detector in proprietary Malvern Panalytical design make the instrument at least **three times more sensitive** than before, delivering **increased speed and precision** of the analysis. Also, trace metals in pharmaceuticals, food, soils and metal ores can be quantified with better precision than before.

Naturally, our engineers have not changed any of Epsilon 1's popular and proven features: the system is still equipped with a built-in computer for easy communication with the outside world. The low-drift X-ray tube does not need extra cooling

and delivers compliant results for years without the need for time-consuming application setup. The hardware design is as robust as before, so that neither dust nor oil can damage the analytical heart of the instrument. The system takes up only 0.15 m^2 of valuable space and is ready for any sample with only minimal sample preparation. With Epsilon 1, costly and time-consuming wet-chemical analysis belongs to the past.

> *Our renowned Epsilon 1 has now been further upgraded with today's technology.*

This makes Epsilon 1 an ideal analytical tool to be taken as close to the sample as possible. There is no need to transport your samples to a lab; just put the spectrometer close to your mining area, in the field or right at your production line, and get started.

To make analyses even easier and more straightforward, Epsilon 1 is also available for specific industry applications. These dedicated versions are pre-calibrated in the factory and ready to use without tedious and costly setup procedures.

EPSILON 1 OUT-OF-THE-BOX SOLUTIONS

Epsilon 1 Lube Oil
Confirming the amount of the additives safeguards the mechanical performance of the lubricating oil in machinery. The pre-calibrated instrument provides ASTM D6481-compliant determination of phosphorus, sulfur, calcium and zinc in unused lubrication oils.

Epsilon 1 Sulfur in Fuel
Fast and precise quantification of sulfur in fuels during the entire refinery process ensures product compliance with the increasingly strict regulations for the oil industry. The pre-calibrated instrument quantifies the amount of sulfur in fuels in compliance with ASTM D4294-10 and ISO 20847.

Epsilon 1 Academia
Easy-to-use measuring routines help introducing students to this widely used analytical technique for screening and elemental analysis of a wide variety of sample types. Epsilon 1 pre-calibrated with the Omnian package for standardless analysis enables the characterization of unidentified samples.

Epsilon 1 for small spot analysis
This member of the Epsilon 1 family enables analyses of very small objects, inclusions or inhomogeneities using a collimated measurement spot (1 mm x 1 mm or 3 mm x 5 mm) and camera for easy sample positioning. The flexible and fast spot-on analysis provides knowledge about the elemental composition of every detail in a sample (like for RoHS-3 regulation). Producers can screen their products for inhomogeneities and make sure that they meet specifications.

"Users of the new Epsilon 1 benchtop systems can benefit a lot from this latest upgrade. It will save them valuable time so they can focus more on other important tasks in the lab."

Dr. Lieven Kempenaers
Product Manager - Benchtop XRF

WHY MALVERN PANALYTICAL'S
CODE OF BUSINESS ETHICS
MATTERS TO OUR CUSTOMERS

Trust and reputation are two of the key attributes that define Malvern Panalytical. The ongoing development of our Code of Business Ethics (CoBE) is the foundation of our relationship with our customers and ensures we're a company that they are proud to partner with. XPress got the chance to talk to Tom Mulder, Vice President Legal, one of the driving forces behind Malvern Panalytical's CoBE.

Tom, can you introduce yourself to our readers?

I studied Law & Economics at the University of Utrecht in the Netherlands and started my career at a law firm. In addition to my work there, I specialized in anti-trust law and became a qualified business mediator. After more than a decade working as an attorney in law firms, I decided to leave private practice and look for a leading in-house position. At Philips Semiconductors (NXP), I gained my first international responsibilities, including acting as General Counsel for a couple of countries. Three years later, I joined a large Dutch company which was a similar size to the former PANalytical. Here, I was responsible for Legal, Human Resources, Compliance and Facility Management as a Board member, and I was involved in several mergers and divestitures.

When did you join Malvern Panalytical?

After eight years at my previous company, I decided that it was time to move on. I believe that it's a healthy business practice for people in such positions to 'rotate' regularly – this gives newer colleagues an opportunity to contribute to their company's future direction, with their fresh new ideas. I started my new role on November 1, 2016, just a couple of months before Malvern Panalytical was created.

What are your responsibilities?

I am a member of Malvern Panalytical's leadership team, headed by our President Paolo Carmassi. I'm responsible for our Legal and Program Management Office (PMO) functions. One of the important items on my daily agenda is the further development of our Malvern Panalytical Code of Business Ethics, including monitoring & compliance.

> *"We act with honesty and transparency in all that we do."*
>
> **Tom Mulder**
> Vice President Legal at Malvern Panalytical

Why is CoBE so important to you?

A CoBE program outlines a set of values by which companies should conduct their operations; providing guiding principles, inspiration, and practical advice on how businesses should work with their partners and communities.

Malvern Panalytical's CoBE empowers our employees to deliver valuable solutions to our customers under the highest ethical standards – we take pride in doing things 'the right way'. For me, this is a prerequisite for doing business with the outside world: you must first make sure that you have your own house in order (CoBE, Health & Safety, Quality etc.). All our employees are regularly trained in all these aspects, and our company values have become second nature to them.

What are the underlying principles of Malvern Panalytical's CoBE?

Integrity is at the forefront of any ethics program, and ours is no different. We act with **honesty and transparency** in all that we do. We understand that treating our employees and business partners with respect, fairness, and an overarching commitment to delivering on our promises creates a partnership that ensures our customers will receive the products and services they rely on to successfully run their businesses.

Similarly, we recognize that our customers are vital to our success, so we do more than simply partner with them to enhance their productivity: we **listen** to our customers' challenges and actively anticipate their future requirements – staying one step ahead. Through **innovation**, we are constantly improving our products and services to find new ways of amplifying their performance and generating maximum value. Our customers never stop innovating and we believe they should expect no less from us.

Our team is committed to satisfying our customers' needs in an ethical and socially responsible manner. Although each of our values is important in itself, their true power arises from their **synergy**; combined, they become much stronger than just the sum of their individual parts. We look forward to sharing our values and demonstrating our commitment to doing things the right way by using this synergy to strengthen the trust and reputation we've built with our customers.

As part of the Spectris Group, we share one CoBE, along with all of the other Spectris operating companies. I firmly believe that successful implementation needs a strong general basis, combined with a personal Malvern Panalytical flavor.

Which of the Malvern Panalytical values is most important for you?

For me, **empowerment** is the basis of every company's success! Our internal empowerment is clear to our customers, who can rely on our employees' commitment to them. And, by extension, our colleagues can rely on us to take the initiatives that continue to bring Malvern Panalytical to the next level.

In my daily work, I like to talk with a lot of people, to celebrate their successes but also to understand what keeps them awake at night. I encourage our people to take initiatives, to think in terms of solutions and to feel empowered to make things happen. For me, that's 'doing business the right way'.

At the time of going to press, Tom has been nominated for the Legal 500 GC Powerlist, which recognizes in-house counsel who are driving business forward.

FROM FIELD TO PLATE - MATERIALS CHARACTERIZATION FOR THE FOOD INDUSTRY

Food scarcity, food safety, food adulteration, and food insecurity are significant problems globally. Add in climate change, land use patterns and an ever-increasing population, and the food industry is continuously challenged to optimize its production processes, guaranteeing quality products that can satisfy the needs of consumers while keeping its activities profitable. Food industry improvements are mainly focused on optimization, reducing processing times, minimizing waste generation and achieving greater product standardization.

A thorough understanding of food properties at every stage of the food production chain is essential for the efficient production of safe food and can be achieved by analyzing various food properties. In many cases, spectroscopy - the analysis of interactions between electromagnetic radiation and matter - can provide this information (i.e., molecular composition, structure, dynamics and interactions).

Food production often begins in the soil: it is important to understand and monitor **soil nutrient levels** to grow our crops and feed the livestock that produces our milk and meat. From assessing **soil fertility to analyzing crop nutrients**, reflectance spectroscopy offers a versatile and precise way to extract important information from soils and crops. Near-infrared (NIR) spectrometers such as the ASD FieldSpec® 4 line can be used to precisely, rapidly and non-destructively measure a wide range of materials, with little to no sample preparation, and can assess multiple constituents in a single scan. Fast and accurate *in situ* spectral field reflectance measurements enable nearly real-time, lab-quality material analysis in the field and can help us determine when to harvest our food, via measurement of moisture content and other characteristics in vines, plants, fruits and vegetables.

Post-production, NIR spectra collected using the ASD LabSpec® full-range spectrometer (350 nm - 2500 nm) and a contact probe can be used to determine raw ingredient characteristics like bread and cake flour **properties of protein (ds), softness (avg.), volume (avg.) and moisture (%)**.[1] Similarly, collected NIR spectra of protein-rich foods, such as fish and meat, can be analyzed and used to create chemometric models (multivariate analysis) to determine quality attributes such as **calories, moisture, collagen and fat**.[2]

The ASD FieldSpec® 4 spectroradiometer used in situ *to measure soil and crop constituents*

Soil applications
- Total carbon levels
- Carbonate levels
- Soil mineralogy
- Erosion

Crop applications
- Stress level analysis
- Nitrogen status
- Water status
- Invasive species

Examples of constituents
- Moisture
- Total carbon/ inorganic carbon
- Total nitrogen/ mineralized nitrogen
- Clay/silt/sand
- Soil organic matter
- Cation-exchange capacity (CEC)
- pH

Process and quality control are essential for the efficient production of safe food. Elemental concentrations of nutrients and toxic metals of interest can easily be measured by X-ray fluorescence (XRF), an accurate, cost-effective and automatable technology. Epsilon 1, a benchtop energy dispersive XRF spectrometer, is fully compliant with international food industry standards (see also page 12). It can, for example, be used for easy **quantification of the most commonly controlled elements in milk powder (potassium, calcium, iron and zinc) or for screening lead in wheat noodles**.[3]

For the determination of **flow properties, texture, stability and microstructural characteristics of food products**, rheology (the study of flow and deformation of materials under applied forces) is applied in food acceptability, food processing, and food handling. The Kinexus range of rheometry instruments can measure:
- Processability – pumping, mixing, extrusion and spraying
- Storage stability – yield stress, viscoelasticity
- Gelation time/rebuild time
- Thermal stability – spreadability, freeze-thaw properties
- Cooking characteristics – viscoelasticity
- Mouthfeel - squeeze flow and pull off

The mouthfeel of chocolate, for example, depends not only on the composition of the fat phase in the chocolate but also on the size of the cocoa, milk and sugar particles suspended in the fat.[4] Laser
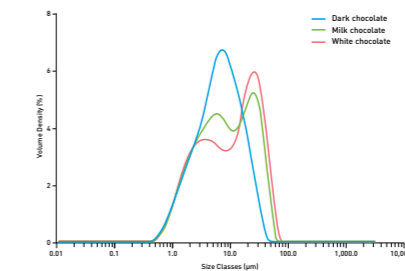
The particle size of different types of chocolate made by one manufacturer

diffraction instruments, such as the Mastersizer 3000, can be used either in a laboratory setting or beside product lines to **determine particle size** at different stages in the manufacturing process. **The crystal structure** of the various components of chocolate is another factor which strongly affects the taste and texture of the final product.[5] X-ray diffraction (XRD) provides structural information about crystalline fats, helping us to optimize the production process for chocolate. Instruments such as Aeris or Empyrean can also deliver structural information for sugar coatings on chocolate – an essential element in the melting behavior of a sugar-coated chocolate.

Post consumption, food scientists are actively researching fats and their fate when we eat them, as well as how they affect our health and well-being. The food industry is developing foods that are sources of 'good' fats (for example, eggs rich in omega-3 fatty acids). Food science is also developing lipids as a 'delivery system' for fat-soluble (lipophilic) compounds such as vitamins, nutraceuticals and nutrients that can be used as 'functional foods' to improve our health.[6] Isothermal Titration Calorimetry (ITC) can be used to **study the factors that influence reactions involving lipids, proteins, or carbohydrates** that play an important role in the digestion of food. Results obtained with our MicroCal instruments may facilitate the design and development of functional food products with improved bioavailability of lipophilic compounds.[6]

Whatever analytical challenge the food industry is facing - Malvern Panalytical has a solution for it!

Read more:
1) Bread and Cake Flour Properties Modeled using LabSpec® 4
2) NIR and Proteins
3) Screening for lead contamination in wheat noodles
4) Understanding the production and perception of chocolate through particle size analysis
5) Exploring the polymorphic structures in Milk Chocolate, Dark Chocolate and Cocoa Butter
6) What I wish everyone knew about Isothermal Titration Calorimetry

KNOW-HOW FOR BRAZIL'S MINING INDUSTRY

The tenth edition of the successful OMA (Ore and Minerals Analysis) workshop was held in November 2018 in Currais Novos, a city in Rio Grande do Norte in North-Eastern Brazil. 76 delegates were graciously hosted by the new Mineral Technology Center of the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN). Professors Alexandre Rocha and Cleonilson Mafra from the IFRN welcomed Dr. Maria Manuela Tassinari and Dr. Juliana Lívi Antoniassi (LCT /USP), Profa. Simone Paz (UFPA) and Dr. Uwe König, Diógenes Silva and Gabriela Lira from Malvern Panalytical as co-presenters of a wide variety of analytical solutions for the mining industry.

The IFRN can reflect on fifty years of mining history from its position as one of the best Brazilian centers for technical education. Many former students of IFRN can now be found working at major mining companies such as Vale, Hydro Norsk, BHP Billiton, Mineração Caraíba, Petrobras, etc.

The new Mineral Technology Center (MTC) in Currais Novos was founded by IFRN, together with Funcern (IFRN's Support Foundation) and the State of Rio Grande do Norte. Currently, the center is housed in a 800 m² building with administration, research laboratories, mining business incubators and a virtual mineralogical museum, which is directly connected with Natal's mineralogical museum.

In October 2018, the MTC founded a partnership with the Gorceix Foundation of the Federal University of Ouro Preto in Minas Gerais. This was only the first of a number of partnerships planned with laboratories and companies from the private sector.

A flotation Mini Pilot Plant (MPP) was the first equipment installed at the MTC in Currais Novos in August 2018 by a team of IFRN's professors, technicians, engineers and by Eriez flotation division representatives. The MPP is a fully automated installation that allows studies of metallurgical recovery in the flotation process. The use of smaller amounts of sample, water and reagents at the MPP decreases experimental costs compared to a usual flotation pilot plant.

The MPP is one of only six mini pilot plants in Brazil and the first of its kind in Rio Grande do Norte. Its installation marks the start of the new technology center, which will extend its facilities over the next few years to become a regional expertise center for the mining industry. The focus will be on research and innovation to characterize ores, on the development of new and environmentally friendly processing technologies, and on the provision of services for mining clients and to offer training courses.

With these goals in mind, the new center was the perfect location for an OMA workshop, with knowledge being shared and delegates benefiting from each other's experience. Malvern Panalytical experts enjoyed the enthusiastic hospitality of the young team at IFRN and look forward to continuing to support MTC with their expertise.

Yuri Souza Gomes, Mining Technician Trainee at IFRN, demonstrating the new pilot plant

KNOW-HOW FOR THE GLOBAL MINING INDUSTRY
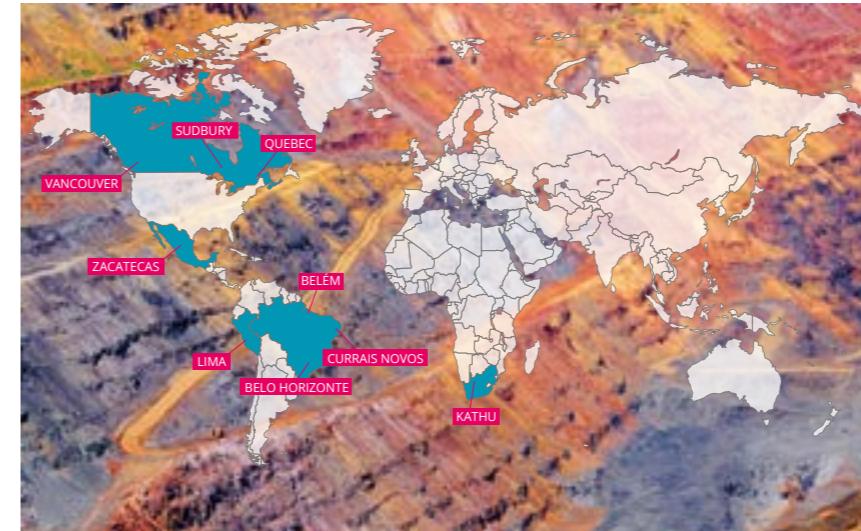
The first Ore & Minerals Analysis (OMA) workshop was held in August 2015 at the Physics Department of the Federal University of Minas Gerais (UFMG) in Belo Horizonte, Brazil. More than 70 delegates from industry and research institutions learned about various possibilities for increasing the cost-efficiency of mining operations.

Delegates appreciate the close collaboration of the host organization - usually a research institution (such as the Universidad Autónoma de Zacatecas, Mexico) or a mining company (e.g. Enviroequip, Peru) - with Malvern Panalytical specialists. This model ensures that the presentations address challenges the mining industry faces on a daily basis.

Today we can look back at 13 successfully organized OMA workshops, proving the attraction of a one-day workshop for the exchange of expertise concerning all aspects of mining.

The reputation of the OMA workshops started spreading beyond South America, with two successful events organized in Sudbury and Quebec (Canada) in the fall of 2017 (see also XPress 1/2018). The first OMA workshop held outside of the American continents was hosted in November 2018 in Kathu, the iron ore capital of the Northern Cape province of South Africa.

"We have planned several more OMA workshops for 2019 in Brazil, Mexico and Canada. In addition, India and Australia will be hosts for the first OMA workshops in Asia," says Uwe König, Malvern Panalytical Global Mining Segment Manager and one of the founders of OMA. "I hope to see you at one of the workshops!"

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