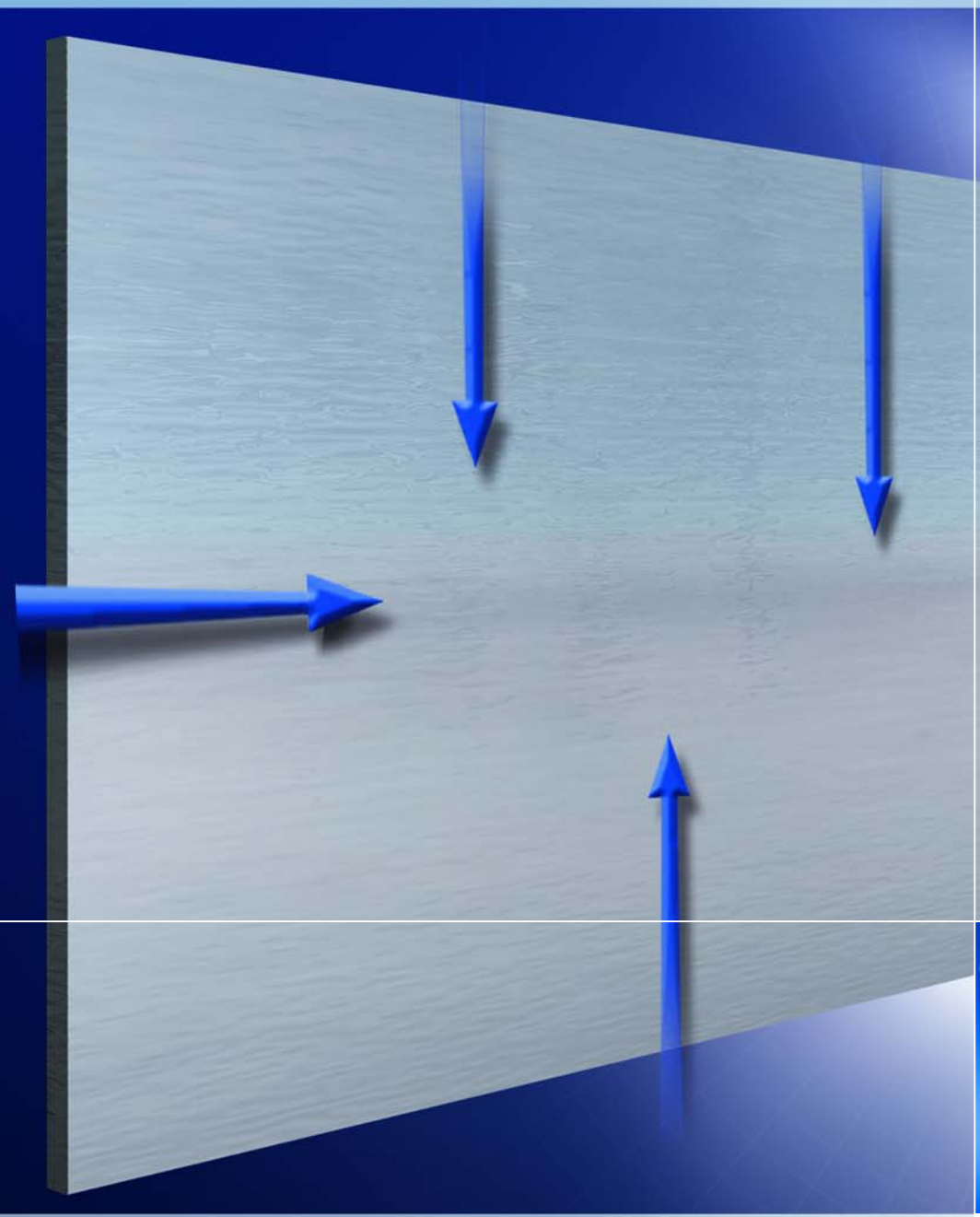
System NMI
Accuracy is the Key



Classifying the Content of Non-metallic Inclusions in Steel in Accordance with Current Industrial Standards

ZEISS

We make it visible.

New Guidelines Require New Priorities: Accuracy has a New Standard

New standards, new methods, new challenges: european standard EN 10247 defines a wide range of requirements for determining the content of non-metallic inclusions in steel. To ensure reliable analysis, this new standard demands one thing above all else: maximum precision of measurement results. In collaboration with experienced steel experts, Carl Zeiss has developed a powerful solution by offering a fully automated image analysis: the NMI system.

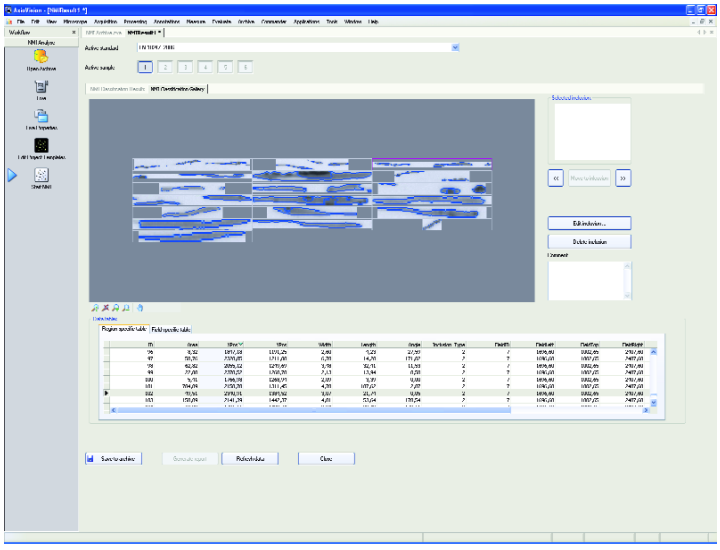
Focused on accuracy: an experience derived method

In order to satisfy the requirements of industrial standard EN 10247 and be able to perform precise measurements, scientists and users have developed the NMI software on the basis of practical experience. The interaction between the system components is designed to record inclusions with precision and performing analyses in accordance with the specified standards.

- Users from the steel industry and their customers, and from research as well as that of experts from Carl Zeiss, have adopted the parameters of all current standards into the design.

The system variants of NMI, based on Axio Imager.Z1m and Axio Observer.Z1m

A result of NMI:
the gallery of largest inclusions



- The image acquisition method allows large sample surface areas to be scanned automatically: inclusions are recorded in their entirety.

- The new optics of the Axio Imager.Z1m and Axio Observer.Z1m high-performance microscopes deliver maximum resolution and strong contrast. In combination with the AxioCam digital microscope camera, even critical inclusions become clearly visible.

Automatically reliable: reproducibility

The motorized stands of Axio Imager.Z1m and Axio Observer.Z1m, automatic image analysis and the possibility of storing setting parameters ensure precise reproducibility – a crucial advantage of NMI when it comes to reliability of operation and the ability to call up previously documented system settings.

Even more efficient: greater flexibility

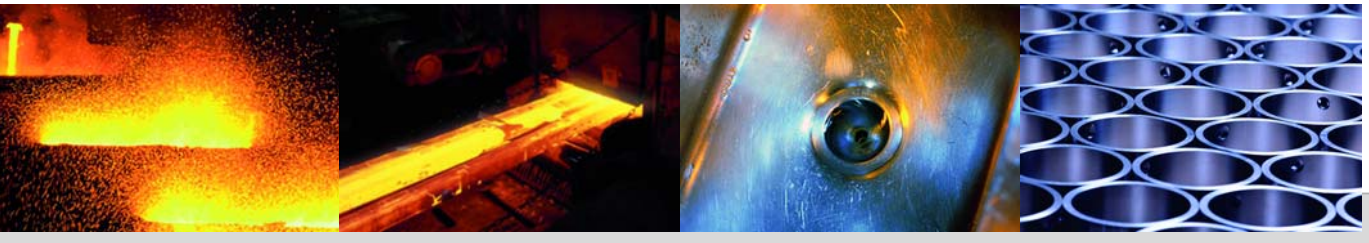
The NMI system has the capacity to cope with several tasks at the same time. It is possible to perform measurements in accordance with all implemented standards simultaneously. Samples are processed automatically and new images can be acquired and the microscope operated during the analysis.

Simply advantageous: digitization

The digitization of samples ensures a new level of reliability is achieved in the area of quality assurance. Samples are documented and archived permanently. Even after a number of years, it is possible to refer back in a reliable way to see how an analysis was performed.

Future-proof and expandable: the optional analysis platform

Should the requirements grow, NMI will be able to grow with them. The system is equipped with all the relevant contrast methods and can be expanded with a wide range of software modules (e.g. Grain Size Analysis), the measurement wizard for routine measurements and hardware components.



A System with a New Class of Performance: the Components of NMI

Wherever work is being carried out in accordance with international standards, a system has to offer not only the utmost in accuracy, but also flexibility and simple operation. NMI from Carl Zeiss allows you to perform classifications in a minimum amount of time and with a minimum amount of effort. In accordance with five standards – simultaneously. No other system is as flexible – or as adaptable, should your requirements grow in the future.

Perfect combination

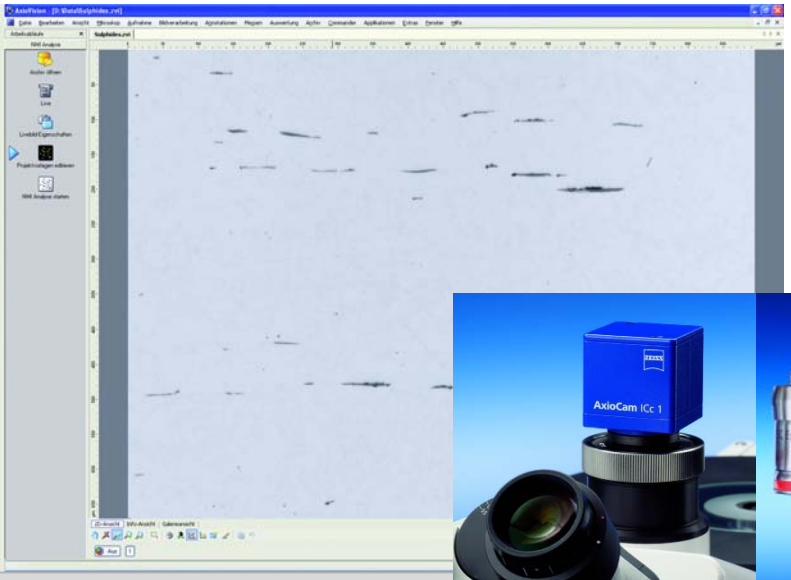
Each individual component of NMI is among the best tools available in the field of digital image analysis. Perfectly coordinated with one another to function as a complete system, they offer you an unsurpassed performance spectrum – tailored precisely with maximum accuracy in mind. These components can be freely combined with a variety of additional components and can be adapted simply to meet future requirements. Existing microscope systems can easily be expanded using the appropriate modules to create a NMI system.

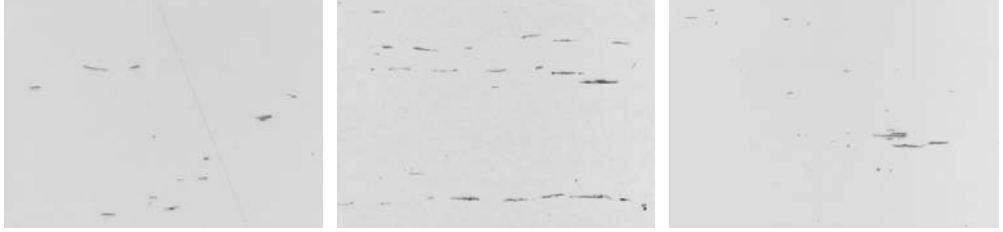
Top class microscopes

The inverted Axio Observer.Z1m microscope and the upright Axio Imager.Z1m microscope are both motorized and optimized for precise, reproducible analyses. Both microscopes stand out thanks to their excellent optics. Your individual requirements will determine whether the inverse or upright option is the one for you.

- Objectives for outstanding contrast and resolution
- Fully motorized for reproducible system settings at any time
- Intuitive and convenient operation with touch screen display
- Extremely robust microscopes

Scanning stages with various traveling ranges are available for both microscopes, which means that it is even possible for several samples to be measured in a single procedure. A multiple sample holder for securing and positioning the samples makes operation extremely simple. Individual holders can even be produced for special samples.





Sulphide inclusions in steel
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Needle-sharp images with AxioCam IC

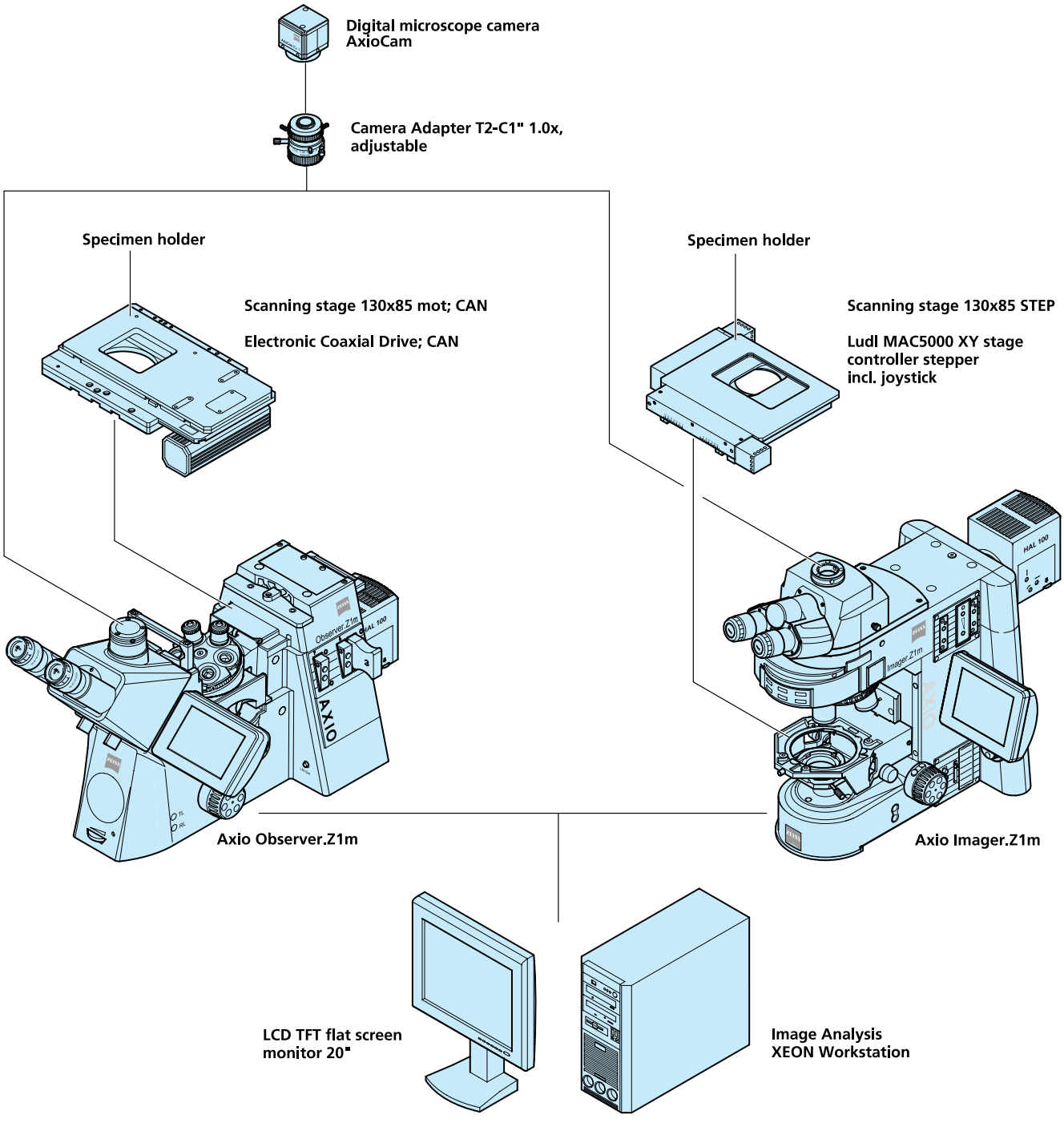
AxioCam IC delivers high-resolution images of inclusions to enable precise measurement. From documentation and analysis when determining the content of non-metallic inclusions in steel to additional measurement and analysis procedures, AxioCam IC performs countless routine tasks in everyday laboratory practice – using 1.4 or 3.3 megapixel resolution. The option is also available of using any of the other AxioCam models with up to 12 megapixels.

Intelligently incorporated into the AxioVision software platform

Using the AxioVision software platform and the tailored NMI software module, you can control all the components and processes involved in determining the content of non-metallic inclusions in steel interactively and fully automatically. The solution offers you compliance with standards, simple operation, a clear user interface and measurements that can be reliably reproduced. The setting parameters of your project template can be transferred to other projects or another system in a freely defined way. Your results remain reproducible at all times under identical analysis conditions.

The components of NMI – a perfect match

NMI – System Overview



Internationality Demands Standards: Standards Create Comparability

The constantly recurring processes carried out internationally by user groups in industry call for binding standardized procedures. These are oriented towards the latest technology and scientific knowledge, as well as economic conditions, and are precisely defined by standards. Now, experts have also reached a new consensus, based on an image analysis method, for the task of analyzing the content of non-metallic inclusions in steel: the new european standard EN 10247.

EN 10247:2006 – classification by means of automatic image analysis

The fundamental innovation of european standard EN 10247 is that the reference charts are based on mathematical formulae. The standard primarily involves an automatic image analysis procedure, rather than the visual comparison of the sample and reference chart image that has usually been employed under the DIN 50602 standard until now. The result of the measurement according to the new european standard is always a concrete value (e.g. length/mm^2) that is not comparable with the parameters of other standards. This means that the possibility of using NMI to perform measurements in accordance with five standards simultaneously is even more important – a comparison is always possible here, as all results are available.

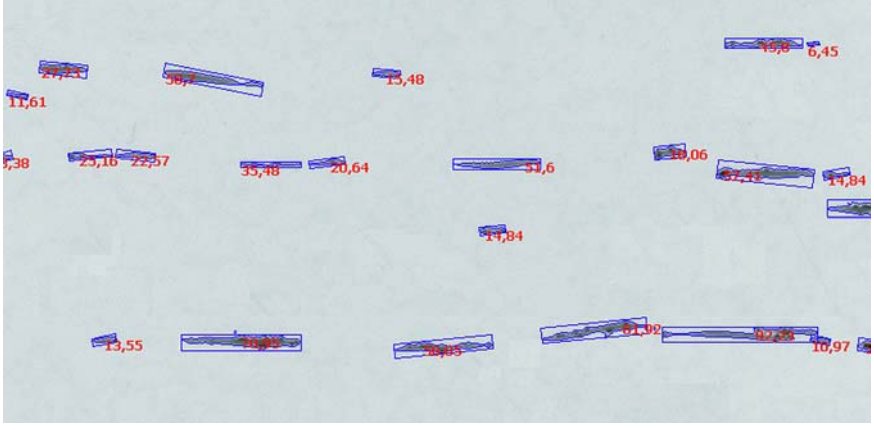
Depending on the method, with NMI the variable parameters can be adjusted individually. Beside EN 10247, the following current standards have also been integrated into NMI:

• DIN 50602:1985
DIN 50602 is the German standard that emerged from the steel test specification "Stahl-Eisen-Prüfblatt 1570". It will be superseded by EN 10247.

• ASTM E45-05
The US standard ASTM E45 contains details on image processing.

• ISO 4967:1998
This international standard has general validity and is similar to the US standard ASTM E45.

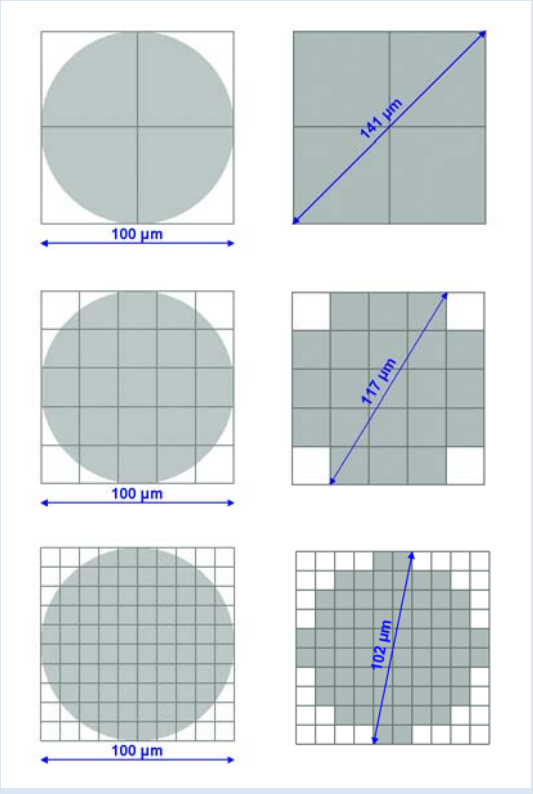
• JIS G 0555:2003
JIS G 0555 is the japanese standard that strongly follows ISO 4967. The image analysis evaluation is identical. JIS G 0555 also describes a manual method.



An intermediate stage of the analysis: each particle is recorded and measured using image analysis techniques

NMI from Carl Zeiss – the Fundamental Principles of Accuracy

The possible applications in which modern image analysis methods can be used know virtually no limits. However, the use of available resources is naturally dependent on certain constraints that must be taken into consideration. Accuracy requirements, process times, data volumes and budgets for the available hardware and software components generally necessitate good compromise solutions. NMI from Carl Zeiss offers a practicable solution for the task of analyzing the content of non-metallic inclusions in steel. It is extremely economical, yet, thanks to its reproducible accuracy, always allows you to be confident in the knowledge that you are working with a reliable system.



Influence of the selected resolution on measurement accuracy. Left: circle with diameter of 100 µm sampled with 2, 5 and 10 pixels. Right: results of the longest diameter.

Resolution is the decisive factor with regard to measurement errors

The theoretical basis for the minimum resolution required is offered by the Nyquist-Shannon sampling theorem. This states that, with regard to the analysis of images, the smallest detail to be resolved must be sampled using at least 2 pixels. For the measurement of a circle, this would mean that the circle is sampled with four pixels. The result in the image would therefore be a square. If the circle has a diameter of 100 µm, the measurement of the longest diameter produces a value of 141.42 µm. This means that it would be measured with an error of more than 40%. In some guidelines it is therefore requested, quite justifiably, that in order to produce a correct measurement, the smallest inclusion to be measured should be sampled with more than 2 pixels. The result for the measurement of a circle with a diameter of 10 pixels for example, is 101.98 µm. An acceptable deviation from the true case of approximately 2%. NMI fulfills this requirement.

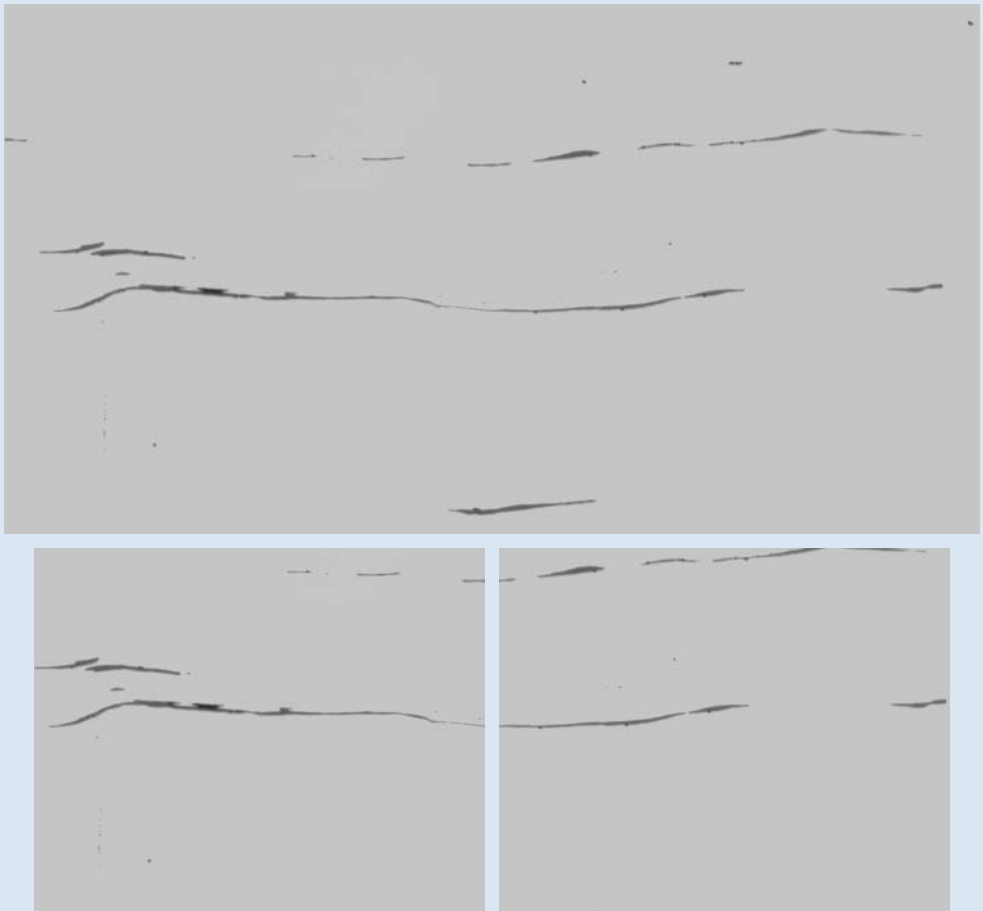
Improving the display of inclusions by changing the resolution

Single image versus MosaiX image

The problem is well-known: just as when a viewer looks through the eyepiece, a camera also only ever sees a part of the sample. In an ideal situation, however, the entire intermediate image of the microscope should be projected directly onto the camera's chip. In the case of a light microscope, the diameter of this intermediate image is 18, 20, 23 or 25 mm.

As a general rule, however, the sensors are a great deal smaller. Consequently, only a part of the image that is visible through the eyepiece is acquired by the camera and displayed on the monitor. For example, in the case of the 8 mm diagonal of a 1/2" CCD chip, approximately 1/8 of a field of view measuring 18 mm is acquired. If single images are acquired, the inclusions are often not displayed and measured in their entirety, but are cut off in several single images. This distorts the result considerably, as it means for example, that two inclusions are measured instead of just one.

In order to avoid this and to guarantee a reliable measurement result, motorized stages are used with NMI, the inclusions that are acquired in single images using the MosaiX software module and then put together to create a large overall image.



If MosaiX images are acquired, large inclusions are recorded in full. However, if single images are acquired, it is possible that some parts of these inclusions will be cut off.

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Accuracy in Focus: NMI at a Glance

Maximum accuracy
High-precision measurements in accordance with standards

Reliable method
Collective knowledge of users from the steel industry and their customers, and from research as well as that of experts from Carl Zeiss

Integrated standards
- EN 10247:2006
- DIN 50602:1985
- ASTM E45-05
- ISO 4967:1998
- JIS G 0555:2003

Reliable reproducibility
Motorized system with automatic image analysis

High efficiency
Time-saving, multiple sample holders available with automated processing of samples

Digitized samples
Documentation of images and data without loss of quality, examination of results with the help of graphics and analyzed image frames, and correction and subsequent interactive processing, as well as sample repositioning

Universal analysis platform
Can be expanded for numerous applications, e.g.
- Grain Size Analysis
- Calotte Grinding Measurement
- Graphite Analysis
- Multiphase Measurement
- Particle Analyzer

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