White Paper

Axio Zoom.V16

More efficiency in materials microscopy

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Axio Zoom.V16
More efficiency in materials microscopy

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Axio Zoom.V16 is a high resolution on-axis zoom microscope by Carl Zeiss with 16x zoom, high aperture and long working distance. A single objective lens lets you zoom from a large object field to the smallest details. The special strength of Axio Zoom.V16 is the acquisition of single and tiled images at low-to-medium magnifications. Given the same object field, you achieve a resolution that is two and a half times greater than with conventional microscopes. This lets you increase your efficiency in terms of image capture and evaluation by a factor of seven. Axio Zoom.V16 is particularly well suited for routine checks of large area samples such as welds, die cast and steel components.

Introduction

In materials microscopy many routine checks involve large areas – for example, when checking the pore structure of die cast components, welds and the hardening zones of marginal layers. A large sample area or complete component is meant to be reproduced efficiently with a medium imaging scale. Your requirements are: well defined details and color fidelity, and a homogenous representation of the structures while acquiring the image as quickly as possible.

In addition to a purely qualitative analysis, quantitative analyses are becoming ever more important. A complete structural analysis also involves analyses with higher imaging scales. Many analyses are conducted at a maximum magnification of 100x or 200x. An instrument that allows for higher magnifications of up to 200x in addition to a high resolution, low magnification range is ideal for this purpose.

Until now, a stereo microscope or a classic compound microscope in connection with special imaging techniques – tiled images, for example – was used for analyses in the low-to-medium magnification range.

Since the high aperture of Axio Zoom.V16 already offers a resolution at low-to-medium magnifications that is two and a half times better than that of conventional microscopes, you can image large measurement surfaces and components up to four times faster. Axio Zoom.V16 is the ideal measurement and documentation instrument.

Examples of using Axio Zoom.V16 for routine analyses

Assessment of the pore structure in die cast components/ welds

Because of the technology involved, the majority of non-ferrous die cast components contain pores. A distinction is made between shrinkage porosity and gas porosity. Owing to physical effects, volume deficits lead to shrinkage-induced cavities during the cooling process – the so-called shrinkage cavities. These are generally characterized by an uneven, cavern-like shape.

Gas porosity is generated predominantly by thermodynamic processes resulting from the absorption of gases by the liquid metal and from fluidic processes causing air to be absorbed during the filling process into the casting tool. Gas pores are mostly round.

Shrinkage and gas porosity are a problem for the mechanical properties, density and surface coating of die cast components so must be checked. These defects generally range very

widely in size from a few micrometers to millimeters and are distributed unevenly throughout the component. The thickness of the walls significantly influences the distribution and location of the defects. In areas with thicker walls, volume deficits often give rise to cavities in the middle of the component. These defects can also occur near the surface. Accordingly, the cavity structure must be analyzed over a wide area and with adequate resolution.

Here the VDG P202 test sheet describes an approach to checking the quality of die cast components microscopically. One of the specifications is an imaging scale of 2.5 and a minimum measuring field of 3x3 mm.

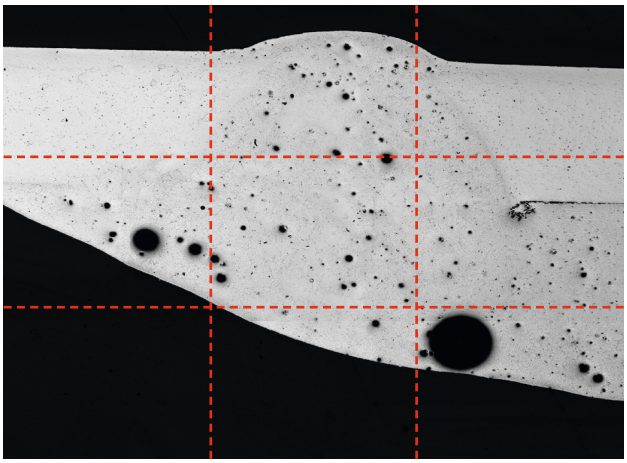
Figure 1 shows an example of using Axio Zoom.V16 to examine a laser weld of AlSi die cast components. The increased porosity within the weld is clearly visible. Based on the P202 test sheet and a compound microscope, it is necessary to put together about nine microscopic tile images to achieve an overall image of the entire weld at a magnification of 25x. The significantly larger field of view of Axio Zoom.V16 allows you to get single images three-to-four times faster compared to a compound microscope. Capturing such an image, including setting up the measurement area, can be expected to take approximately four-to-five minutes with a compound microscope. Axio Zoom.V16 allows you to capture a comparable image of the same (and at times better) quality in just one minute. This is a significant improvement when conducting serial analyses, and it also gives you the option of quantifying porosity and pore sizes.

Figure 1

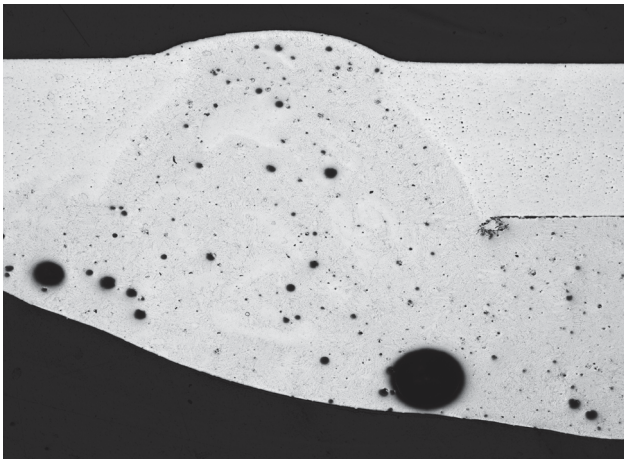
More efficient image acquisition (by a factor of 3-4x) with Axio Zoom.V16: microscopic quality analysis of laser welds of AlSi die cast components

a) Axio Imager.Z2m, 3x3 MosaiX image with imaging scale of 2.5, digital resolution of 2.58 µm/Pixel

b) Axio Zoom.V16 with imaging scale of 1.0, digital resolution of 2.19 µm/Pixel



Axio Imager.Z2m, 3x3 MosaiX, imaging scale of 2.5



Axio Zoom.V16, single image, imaging scale of 1.0

When using a compound microscope, you put together several low magnification microscopic images by using the software module MosaiX, but this often brings up problems with uneven illumination (shading) and the correction of overlapping areas (stitching), as shown in Figure 2a).

Comparable areas of use for Axio Zoom.V16 are in the field of injection molded plastic components and welds of steel components. Almost the same problems regarding the formation of cavities crop up in injection molded plastic components. The examination of welds in steel components requires mainly geometric measurements. This is where the advantages of Axio Zoom.V16 come into play. High apertures are achieved at low-to-medium magnifications. Structural details in the heat-affected zone are shown at magnifications up to 150x.

Increased efficiency by a factor of 5-7 in the documentation of hardening zones in marginal layers of steel components

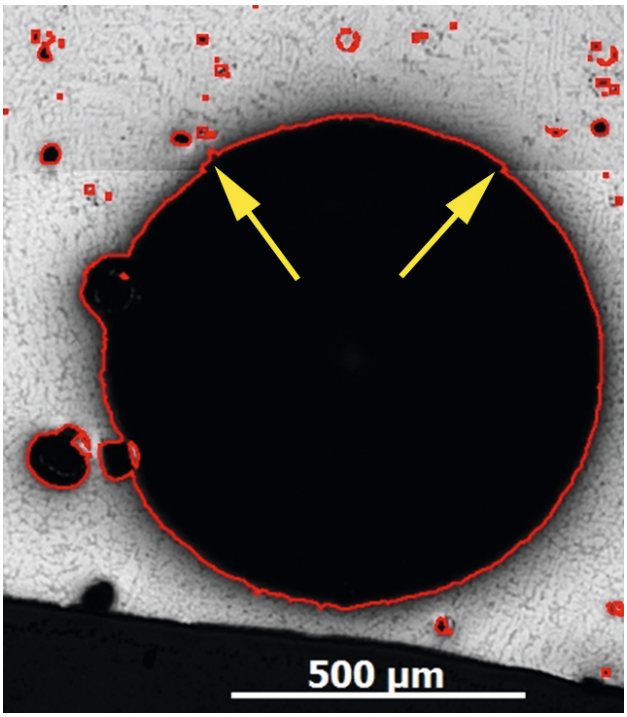
To improve the wear and tear properties of steel components, their marginal layers can be treated with thermal (e.g. induction hardening, laser hardening) and/or thermo-chemical surface hardening processes (e.g. case-hardening, nitriding). The goal of these processes is to improve properties such as hardness and the introduction of compressive stresses in the surface of steel components (e.g. crankshafts and camshafts, drive shafts). It is necessary to determine quickly and efficiently the width, depth and position of the hardening zone, especially when analyzing induction-hardened marginal layers. The hardening zone must be measured as efficiently as possible for a multitude of samples, in particular when introducing a new inductive hardening process. Especially when measuring small and difficult components with hardening depths in the millimeter range, you need a microscopic assessment of the hardening zones, and Axio Zoom.V16 does this efficiently.

Figure 2

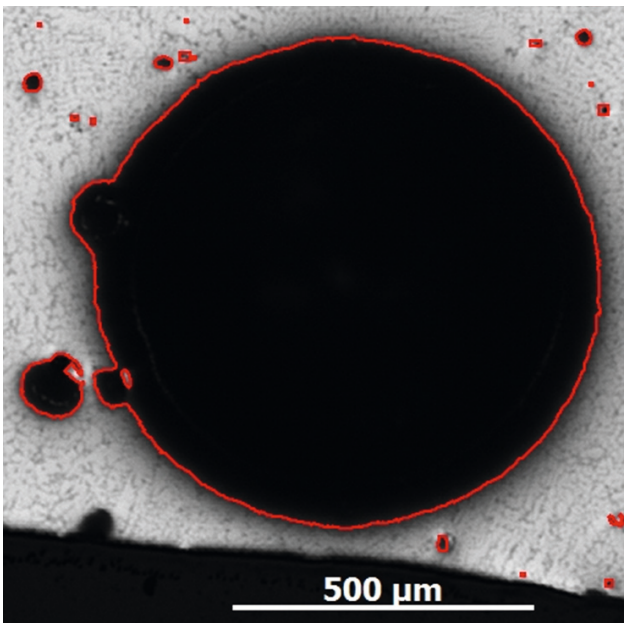
Example of detail recognition showing the largest pore in a die cast component, full scale with false-color representation of pores detected through image analysis

a) Axio Imager.Z2m with few shading and stitching artifacts (see arrows)

b) Pore with Axio Zoom.V16 without artifacts



Axio Imager.Z2m, detail

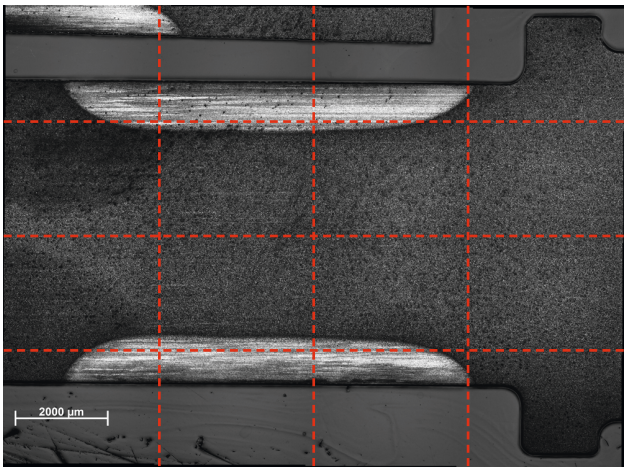


b) Axio Zoom.V16, detail

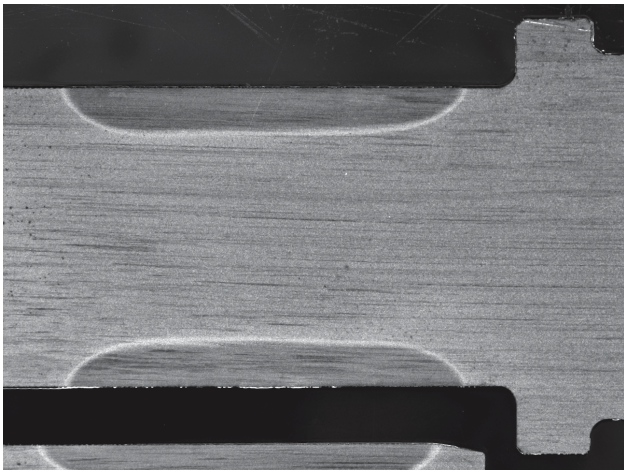
Figure 3 shows comparative microscopic images of an induction- hardened zone captured with Axio Imager.Z2m and Axio Zoom.V16. While the representation and measurement of the induction-hardened zone with Axio Imager 2 requires a MosaiX image with 4x4 tiles at an imaging scale of 2.5, the zoom optics of Axio Zoom.V16 allow for clear advantages in taking single images at an imaging scale of 0.63. The advantages are essentially the speed with which an image can be captured, uniform illumination and more efficient implementation of the measurement task. In specific cases, the efficiency in assessing 60 induction-hardened steel components could be increased by a factor of five. This increased efficiency is substantially the result of the faster acquisition of images implicit in capturing a single image, much simpler handling as several focus corrections with Axio Imager 2 no longer have to be set up, and the reduction of the subsequent image processing required. Furthermore, Axio Zoom.V16's ring light illumination shows better contrasts of the various hardening zones. In particular the more recognizable transition shown in Figure 3b) allows for a faster and simpler measurement of the hardening zone.

Figure 3

Axio Zoom.V16 allows more efficient measurement of marginal hardening zones (e.g. induction-hardened shafts) that's five times faster during serial analyses.



a) Axio Imager.Z2m, 4x4 MosaiX, imaging scale 2.5, reflected illumination



b) Axio Zoom.V16, single image, imaging scale 0.63, ring light illumination

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