# ZEISS ZEN 2 core

Fast Routine Investigation of Additive-manufactured
Al-Si Samples

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## Fast Routine Investigation of Additive-manufactured Al-Si Samples

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**In the past few years, additive manufacturing has been revolutionizing the production of components made of plastic, metals and metal alloys, of which the especially high degree of structural and geometric options offer great potential. Defects in the structure of the manufactured components significantly reduce their application properties. The materialographic examination of the samples prepared for process development and sporadic quality control is therefore indispensable. Using the example of additive-manufactured Al-Si samples, this application note shows the suitability of ZEISS ZEN 2 core software for fast and comparable routine investigations into this microstructure.**

## Introduction

Quality control for additive-manufactured components requires checking and reviewing the structure and its dimensional accuracy. The ZEISS ZEN 2 core software's 'supervisor-operator' structure allows the appropriate routine procedures to be created and for them to be executed quickly. Using ZEISS ZEN 2 core software, the 'supervisor' first creates the 'job' using a microscope – a ZEISS Axio Zoom.V16 microscope, for example. In this job, the 'supervisor' defines the steps necessary for investigating the manufactured samples and determines the current microscope and software settings. In order to conduct a routine sample analysis – for example, a quality-assurance analysis – the 'operator' calls up the stored 'job', which guides the 'operator' through the investigation, thereby guaranteeing comparability of results.
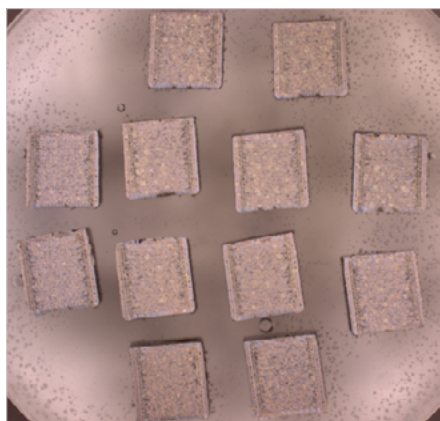
## Creating 'jobs' for routine examination of additive-manufactured Al-Si samples

**Qualitative structure analysis: Overview image, tile picture and 'best image' function**

ZEISS ZEN 2 core software is able to microscopically check several additive-manufactured Al-Si samples and analyze their structure – both qualitatively and quantitatively – within a single operation. For sample documentation, the 'supervisor' first creates an overview image of the microsample in which 12 components are present as multiple embedded elements (see Figure 1a).

Highly magnified images achieved using the 'best image' function (see Figure 1b) are suitable for undergoing qualitative structural analysis. First, however, a live image
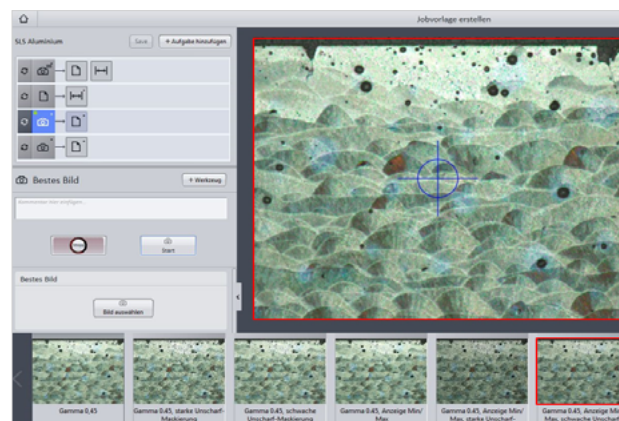


***Figure 1 a)*** *Overall view of the 12 additive-manu-factured Al-Si samples embedded in a microsection.*



***Figure 1 b)*** *Applying the 'best image' function in preparation for the qualitative structural analysis.*
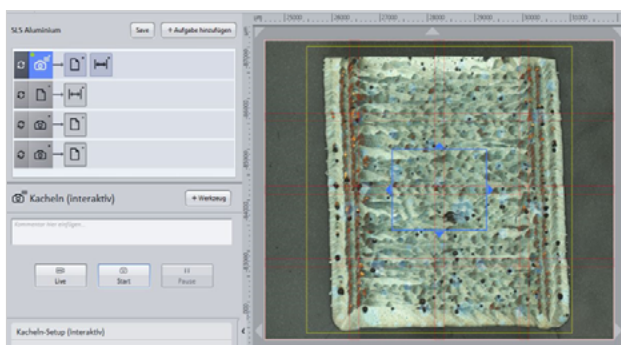
**Figure 2** *Setting up the tile image with the tool 'interactive tiles'.*



**Figure 3** *Measurement of porosity. a) Create the image-analysis wizard; b) adjust the threshold; c) output image with segmented porosity (red) and measured-value table.*

with optimized exposure time and autofocus needs to be prepared. Depending on the live image settings, eight images are taken that vary in terms of their gamma values (the change in brightness and contrast). These images are displayed in an image strip and the 'supervisor' selects the best picture (outlined in red in Figure 1b).

Tile images will be created of each sample at high magnification (see Figure 2) for later quantitative microstructural analysis (QGA) using the tool 'interactive tiles'. Tile imaging makes it possible to display the entire component at high magnification in a single image, which is of great advantage when conducting a quantitative assessment of the microstructure. The 'supervisor' defines a measurement framework – this definition includes the image parameters and camera settings – so that the 'operator' only needs to perform the measurements, which in turn produce more comparable microscopy images.

**Quantitatively determining the porosity ratio using 'image-analysis wizard'**

The 'image-analysis wizard' quantitatively analyzes the porosity of each individual microsample of the tile images that were created earlier. In the seven-step wizard, the 'supervisor' defines the parameters for threshold analysis. Steps include defining the object classes (Figure 3a), selecting the measuring range using a measuring frame and the necessary measurement characteristics, and adjusting the threshold values (Figure 3b). The 'interactive segmenting' step allows pores that were not recorded during 'automatic segmentation' to be manually selected later on. The output image (Figure 3c) shows the segmented pores in red; the measured-value tables can be saved with the desired measurement characteristics.
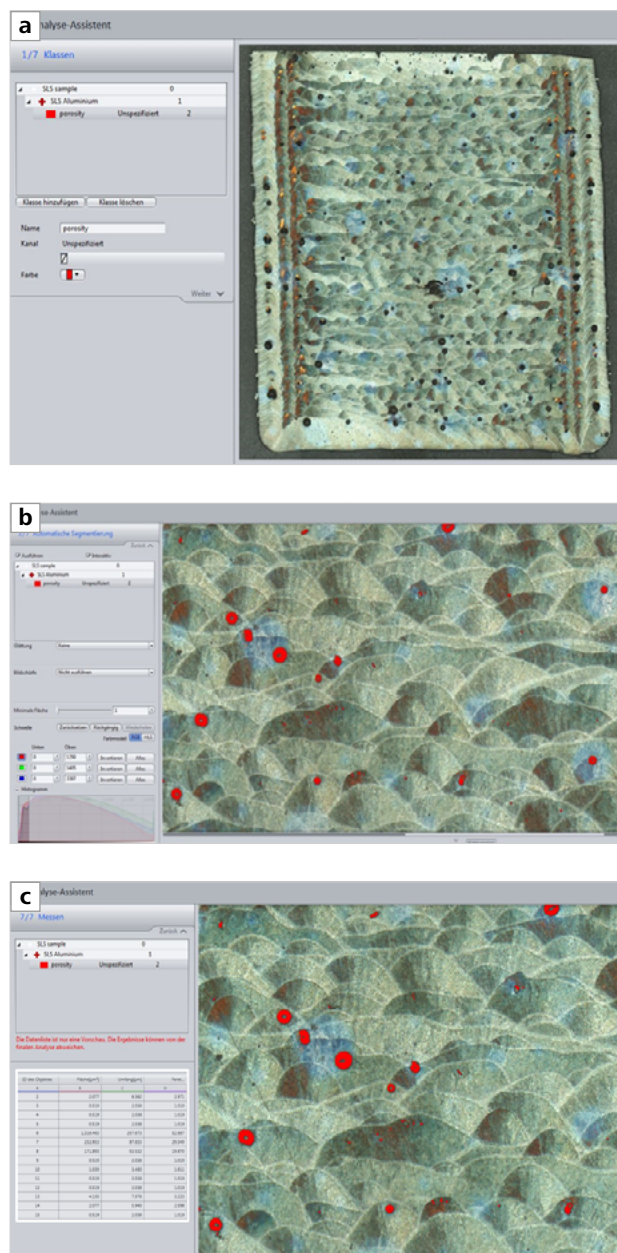
**Surveying sample geometry and structures using the 'interactive image analysis'**

The quantitative description of additive-manufactured Al-Si samples is supplemented by measuring layer thicknesses and component dimensions on the tile image created earlier. The 'supervisor' defines the initially measured favorites using the 'interactive measurement' tool. The lengths, widths, and diagonal measurements of the samples, as well as their
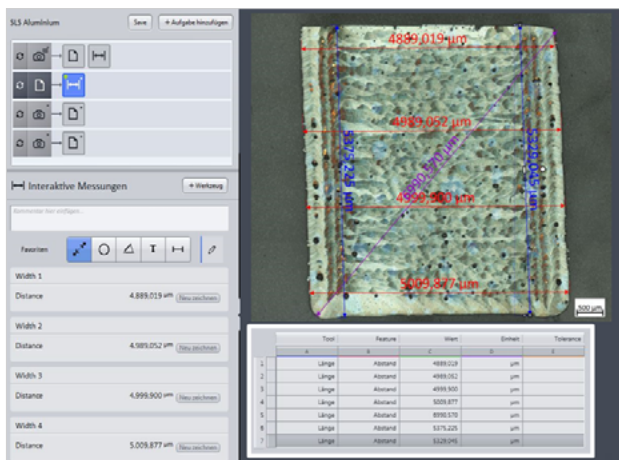
**Figure 4** *Measuring component dimensions and structures using the interactive measurement tool. The measurement results are displayed in a table format.*



**Figure 5** *Simplified quantitative microstructure analysis for determining porosity in operator mode.*

individual structures, are measured and simultaneously displayed in the bar on the left (Figure 4). The scale is set automatically. The measured values are then displayed in a table that can be stored.
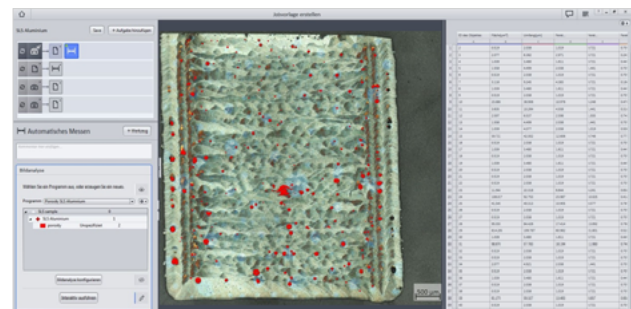
## Running the 'job'

The 'job' that the 'supervisor' created using the individual procedures described earlier now guides the 'operator' through the investigation, step-by-step. The respective microscope settings and recording modes are predetermined. The 'operator' only has to position the samples, hit the desired locations, and record the images. The porosity is determined in four steps in a simplified quantitative microstructural analysis, in which the measuring parameters, measuring frames, and thresholds are defined (Figure 5). When measuring the components and internal structures, the measuring tools are preset; the 'operator' has to adjust the starting points for the measurement lines.

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