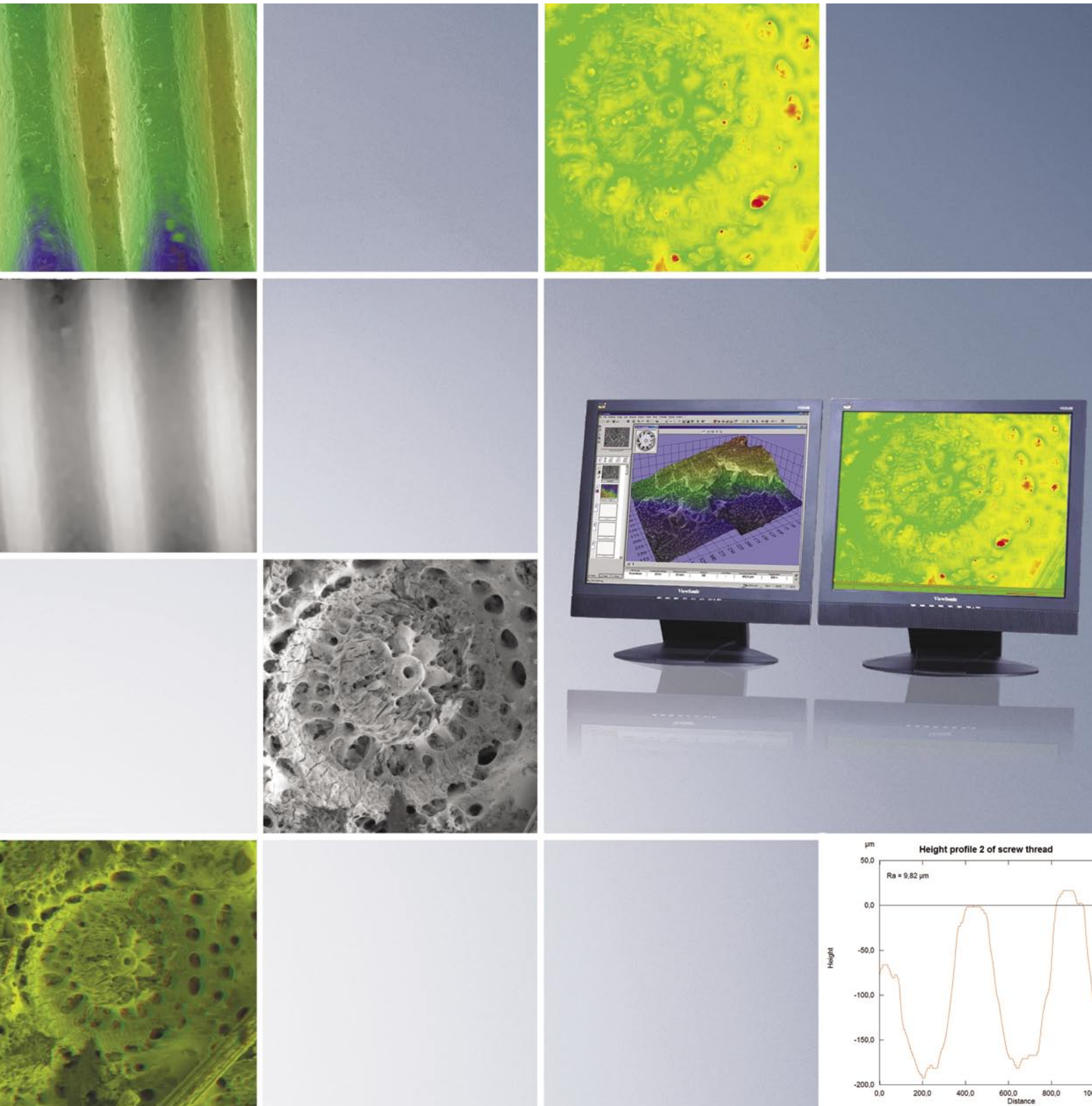
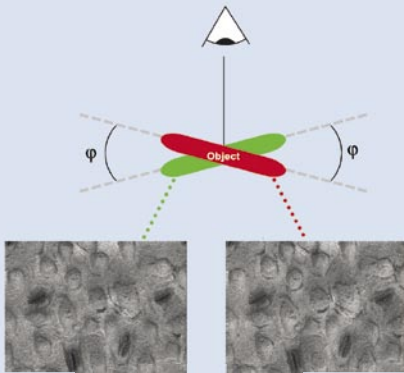


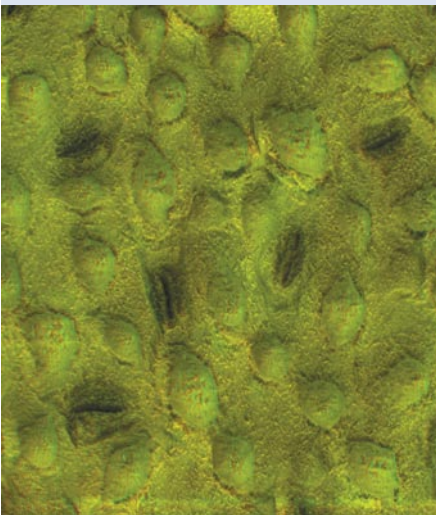
## 3-D Visualizations and Evaluations of SEM images



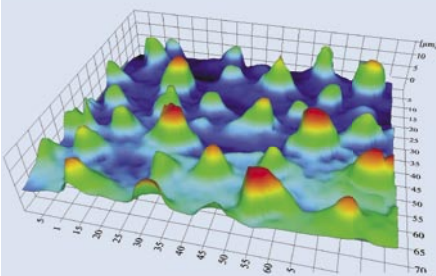
### A Stereo image pairs



### B Anaglyphic display Vivid visual impression



### C 3-D surface 3-D reconstruction of the surface



## 3-D VISUALIZATIONS AND EVALUATIONS OF SEM IMAGES

The Scandium Solution Height expands SEM functionality to offer 3-D analysis. The software provides automatic calculation of three-dimensional models of tilted SEM images, topography visualization, and comprehensive evaluation and measurement routines for 3-D images. All results can be easily archived, documented or more extensively analyzed. This extension requires no special hardware and works with all standard scanning-electron microscopes. As with all other extensions, the Scandium Solution Height is fully integrated with Scandium, the Olympus Soft Imaging Solutions scanning electron microscopy image analysis platform. The core version offers numerous functions for processing, analysis, visualization and archiving of images and other data as well as for automation and report generation. With its solution-oriented software extensions, Scandium's range of functions can be precisely expanded according to the user's needs.

The human brain calculates spatial information based on different images generated on the retina of the left and right eye of any object looked at. This enables humans to see spatially and to estimate the distance to various objects in space. The images on the left and right retinas differ because of the different viewing angles of the two eyes (which is due to the distance between the two eyes). Scandium Solution Height operates similarly to the processes of seeing stereoscopically. Stereoscopic views can be generated and pixel height can be calculated using two images showing the same object before and after tilting it at a specific angle. The two images are referred to as a stereo image pair.

### Acquiring stereo image pairs

**A** When acquiring stereo image pairs the stage of the scanning-electron microscope (SEM) is tilted for the first image initially at any user-definable angle in one direction and then by the same angle in the other direction for the second image. For remote-capable SEMs, Scandium automatically saves all microscope parameters with the image information. All parameters are read out directly for the subsequent evaluation.

### Image animation and anaglyphic display

**B** The stereo image pair can be displayed in a wide variety of ways within Scandium. The viewer immediately notices any pixel shift along the X axis by tilting the object. The X shift can also be impressively emphasized using an anaglyphic image. At a tilt angle of about 5° or 6°, the image gives the viewer a three-dimensional impression of the object. An anaglyphic image is where the images of the stereo image pair are superimposed in two different colors – eg, red and blue. When an anaglyphic image is viewed with blue-red stereo glasses, each eye simply sees the corresponding image area only. Each eye thus receives different image information, just like when seeing in 'real life'. This makes a vivid visual impression.

### 3-D surface

**C** The three-dimensional reconstruction of the surface gives a quick impression of the sample's consistency. Height map information is evaluated for display. The height map displays height information as various gray values: for lower positioned object areas darker gray values are used, for higher object areas lighter gray values. An image of the stereo image pair is used as the texture of the 3-D surface. The correlation map or height map may be used also. Alternatively, the image can also be displayed using what is called a false-color table (LUT) where the height differences are much more readily visible for the human eye. The 3-D surface has numerous

visualization options. It can be rotated and tilted in all directions. The viewer can zoom into the surface, define animated sequences, save them as an AVI file and then play them back.

## Image Stacks

Image stacks also contain the height map and the correlation map in addition to all stereo-specific information for the evaluation and visualization of the stereo image pair. If necessary, all images of an image stack can be extracted. Individual images do not have to be retained as all important information is contained in the image stack. This makes managing stereo images a lot easier.

## Height map and correlation map

**D** The height map is for determining height information. The gray values of the image are height coded. The lighter the gray values, the higher that area of the object. The correlation map provides information on the correlation value between individual image areas. This value indicates how reliably the software was able to detect certain image structures within both images. These image areas are color coded according to the quality of this value. This makes it easy to estimate the reliability of the height reconstruction at a glance.

## Height measurements

**E** Numerous parameters are available for measuring the stereo image stack. These include generating the height profile along a line or a polyline, determining the absolute height of a point and the height difference between multiple points.

## Roughness

Roughness is a special software tool in the Scandium Solution Height for non-contact measurement of roughness and waviness based on topographical images. Roughness standards according to DIN, ISO and ASTM are supported. The following are supported: measurement of practically all height parameters ( $R_a$ ,  $R_z$ ,  $R_y$ ,...), calculation of waviness and the detailed evaluation of material composition curves (core roughness depth,...). In addition, all profiles can be shown (measurement profiles, roughness, waviness). Filter characteristics can be specified as defined by the user or according to DIN, ISO, ASTM.

## Images with unlimited depth of focus

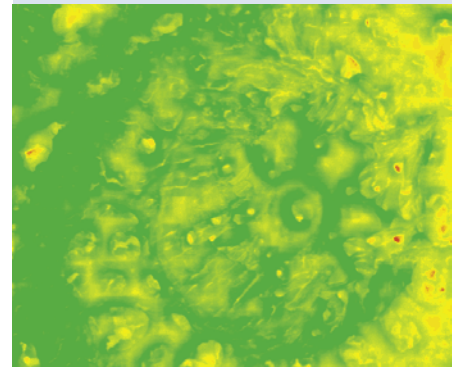
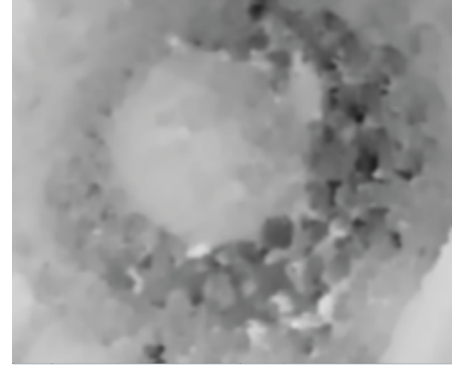
Scandium Solution Height includes the efi (extended focal imaging) module. This software tool acquires images at different focal positions and extracts the sharpest detail from each image respectively. efi takes all component images and combines them to create one, very sharp image with infinite depth of focus. efi supports automatic montage of color and b/w image series. efi supports furthermore the generation of height maps from the component images.

## Programming

Scandium Solution Height includes the programming language Imaging C. Imaging C provides users with the C programming language and high-performance image-processing libraries containing more than 8000 commands. Windows API commands and commands from external DLLs are supported. This software extension includes a compiler and a debugger. Programs created using imaging C can be run as add-ins in Scandium.

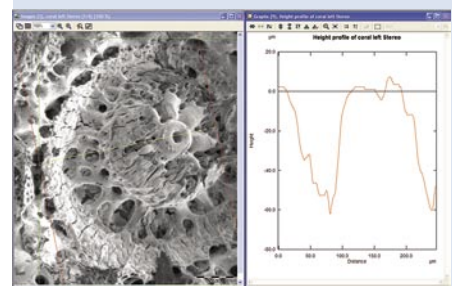
### D Height map and correlation

Estimation of reliability



### E Evaluations

Numerous measurements of heights, roughness and waviness



## Specifications

- Stereo
  - Quantitative, qualitative, animated results
  - Stereo images
  - Perspective views
  - Select zero level
  - Select stereo colors
  - Subpixel precision
  - Automatic brightness adjustment of individual images
  - Fast-scan measurements
  - Measurement of height, height differences, lines, polygons, areas
  - Surface elevation maps
  - Measurement verification/ check
  - Perfect-Spike-Removal filter
  - Save/store parameter sets
  - Save/store measurements
  - Data presentation: Sheets, Statistics, Diagrams, Overlays
- efi
  - Automatic montage of image series generating images with crystal clear depth of focus
  - Pre-alignment of images with lateral displacement
  - Height map
  - 3-dimensional representation
- Roughness
  - Determining roughness parameters using height-coded images
  - Measurements according to DIN, ISO, ASTM

## Additional Scandium Solutions

Scandium can be further expanded according to your individual needs via a wide range of specially developed solutions. Users can thus put together a personalized software solution for their particular application. All solutions work together seamlessly. The list of the available solutions is growing continually.

**Scandium Solution Volume** – The Scandium Solution Volume enables users to display and navigate within these 3-D image stacks

**Scandium Solution Metallography** – The Scandium Solution Metallography combines various functions for analyzing metallographic samples quantitatively.

**Scandium Solution Detection** – The Scandium Solution Detection offers comprehensive particle analysis functions

**Scandium Solution X-Ray** – The Scandium Solution X-Ray combines several tools for dealing with microanalysis systems.

**Scandium Solution Automation** – The Scandium Solution Automation provides a universally expandable application environment for fully automatic control of motorized stages and quantitative analysis processes.

**Scandium Solution Metrology** – The Scandium Solution Metrology is comprised of special functions for automatically measuring object structures.

**SEM Interface ADDA<sup>3</sup>** – The ADDA<sup>3</sup> is the Olympus Soft Imaging Solutions answer for those with older, analog scanning devices (SEM, STEM) yet requiring a digital, image-acquisition system. The digital scan interface guarantees a broad dynamic range, speedy image acquisition and tremendous flexibility.

Specifications are subject to change without any obligation on the part of the manufacturer.  
Soft Imaging System is a trademark of Olympus Soft Imaging Solutions GmbH

[www.olympus-sis.com](http://www.olympus-sis.com)  
[www.soft-imaging.net](http://www.soft-imaging.net)

**OLYMPUS**

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