Accessory for HAAKE Rheometer

SPIP software for analysis of RheoScope images

The RheoScope module is a compact modular accessory for the HAAKE MARS high-end rheometer providing simultaneous recording of rheological properties and images of the microscopic structure. The software HAAKE RheoWin displays the rheological data as well as the microscopic images at the same time during measurements as well as for later evaluation. Saving data points and images in the same file facilitates definite correlation between both of them. For further analysis, data and images can be exported or stored in various formats.

The image analysis presented below was performed by means of the image analysis software SPIP (by Image Metrology). The used package (order number 098-5052) consisted of the SPIP base module expanded by roughness analysis and grain analysis.

For analysis in SPIP, microscopic images have to be selected in HAAKE RheoWin and saved either in BPM or TIFF format. Then the images can be loaded into the SPIP software. A right mouse click on the image gives access to the properties of the image. By using the parameters below the scaling of the image can be adapted from pixels to microns.

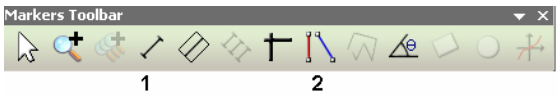
	X	Y	Z
Unit:	[µm]	[µm]	[arbitrary]
Range:	220.000	164.000	255.000

Key-words

- HAAKE MARS
- RheoScope module
- SPIP image analysis software
- Standard particles
- Emulsion
- Liquid crystal
- Particle size determination
- Particle size distribution
- Structural analysis
- Microstructure
- Orientation

1. Determination of particle size

A mixture containing standard particles with diameters of 1.5 as well as 4.0 and 8.0 µm was measured with the RheoScope module. Figure 1 shows the SPIP analysis of the enlarged section of one of the resulting images. Selection of "Single line profiling cross section by single line" (1) in the menu "Markers Toolbar" determines the diameter of a single particle whereas selection of "Multi line profiling cross section by multi line" (2) determines the diameters of several particles.



The SPIP software displayed a line through each selected particle. The intensity distribution along each line was determined and displayed in the regarding color in a further graph from which the diameters of the selected particles could be evaluated (Fig. 1).

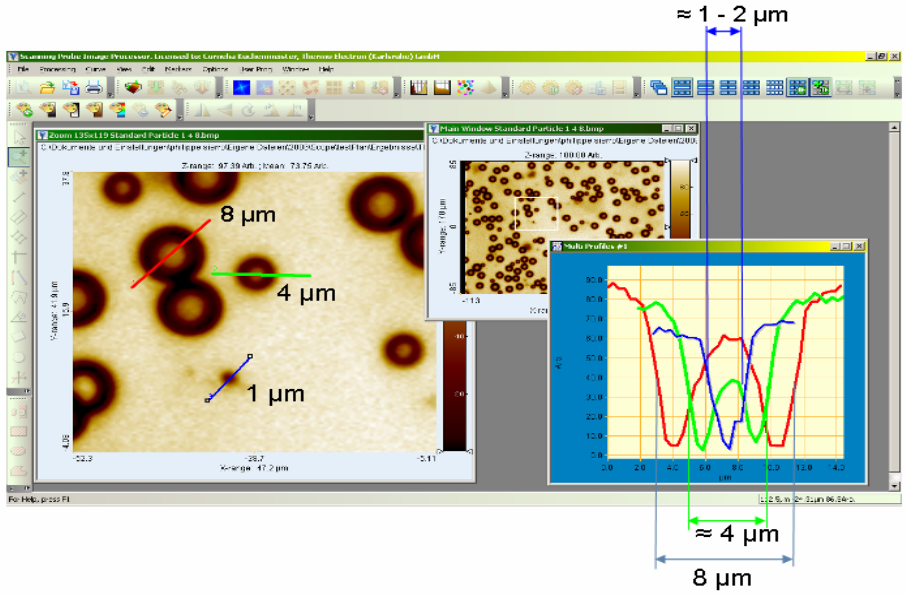


Fig. 1: Screenshot SPIP software: an image of a mixture containing different standard particles recorded with the RheoScope module (middle); magnified view with three selected particles (left); intensity as a function of diameter of the selected particles corresponding to the particle size (right)

Dr. Cornelia Küchenmeister
Dr. Philippe Sierro
Dr. Fritz Soergel

Thermo Electron (Karlsruhe) GmbH
Dieselstrasse 4
76227 Karlsruhe
Tel: +49 (0) 721 4 09 44 44
Info.mc.de@thermo.com

www.thermo.com/mc

2. Determination of particle size distribution

An image of an emulsion from the food industry was analyzed using the "Grain/Pore Analysis" which is found under the "Processing" menu. This analysis begins by creating a contour image which is followed by an image which uses color to identify particles of the same size range. From this image the particle size distribution can be determined and visualized in a bar diagram (Fig. 2).

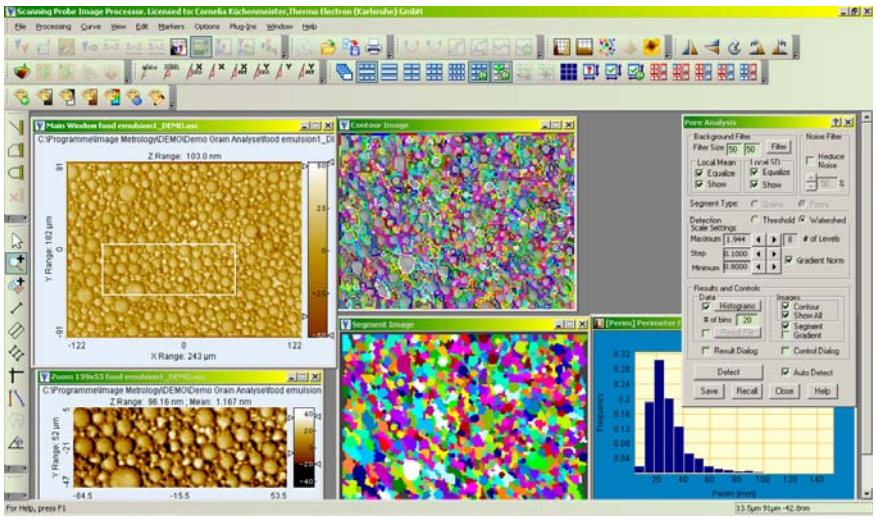


Fig. 2: Screenshot SPIP software: an image of food emulsion created using the RheoScope module (upper part, left), magnified view (lower part, left), contour image (upper part, centre), image showing particles with same size in same color (lower part, centre), analysis and diagram of particle size distribution (right)

3. Structural analysis

An image of a liquid crystalline structure which was built up under shear during a rotational experiment was analyzed using the "Roughness" function in the menu "Processing". As the result, the angular distribution diagram of the orientation vs. correlation length (particle diameter) was displayed with maxima at 0°, 180° and 120° (Fig. 3). By Fourier transformation, a two dimensional intensity distribution (scattering image) was generated. A line can be manually drawn in this diagram. The intensity along this line is shown in an additional diagram. The intensity maxima are reflecting the diffraction orders: Zeroth order at 0, 1st order at 1/125 nm (particle size 8 µm), 2nd order at 1/250 nm.

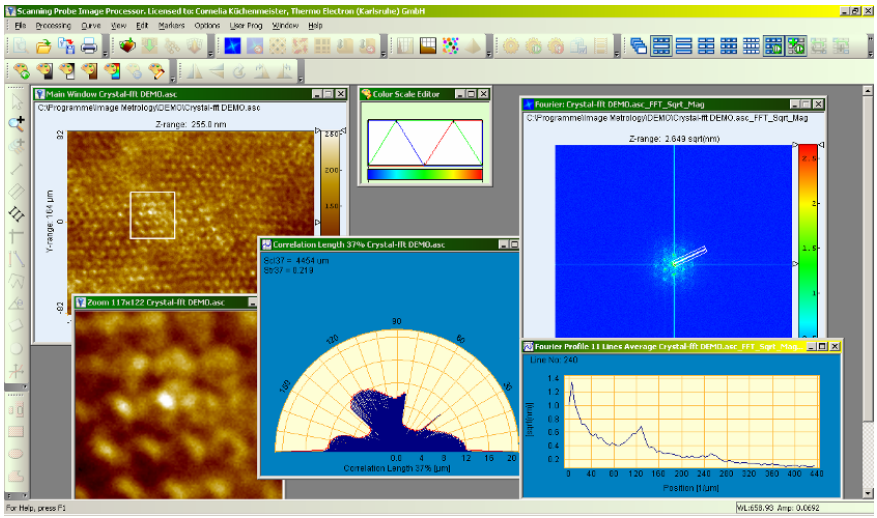


Fig. 3: Screenshot SPIP software: an image of a liquid crystal taken with RheoScope module (upper part, left), user-definable color setting (upper part, centre), magnified view (lower part, left), diagram of the angular distribution of orientation (lower part, centre), Fourier transformation with manually determined line (upper part, right), distribution of intensity along this line (lower part, right)