

ImageSP is the imaging software specially developed by TRS & SYSPROG for electron and light microscopes. ImageSP provides a comprehensive work environment for image acquisition, processing, analyzing, storing and easy report generation. The functionality of the program meets all requirements of scientific microscopic the studies. ImageSP is modular and can be configured specifically for each application area. The program consists of the core module and additional modules, which can be included into the program. The core functionality of ImageSP allows to scan, correct, view, process, analyze, save, load and print generate reports and much more. Optional images, modules of ImageSP are: Panorama, EFTEM, Analyze Particles, Diffraction Analysis, Script Engine and Drift Correction. We also provide a demo version of ImageSP which contains basic functionality, without possibility to scan, save or print. To get the demo version, please contact us.

### ImageSP is presented by TRS & SYSPROG

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From left to right: image-window with different metric tools, Colouring window and colored image, DataBase of images.

# Core functionality of ImageSP

### **Microscopes & Platforms**

- Connection to all Carl ZEISS electron microscopes and JEOL; extendable list of supported TEMs.
- Specification of COMMANDS sent to electron microscope on different stages of scanning.
- Support of the EFTEM module for Carl ZEISS transmission electron microscopes.
- Automatic acquisition of panoramic images using GONIOMETER or SHIFT SYSTEM (for Carl ZEISS TEMs only).
- Working with all types of LIGHT MICROSCOPES equipped with CCD or video -cameras.
- Operational system Windows 7/10 64-bit.

#### Sensors & Interfaces

- Working with different types of image data acquisition devices provided the driver availability: CCD-cameras, camcorders, scanners (via TWAIN protocol) etc.
- Support for color and monochrome CCDs with possibility of accurate sensor setup; support of all TRS CCD cameras.
- Support of different interfaces, in particular through serial buses USB.

### Scan & Control

- Setting the EXPOSURE time or usage of AUTOEXPOSURE control mode by intensity during scanning.
- Different scan modes: 1 SCAN (single shot) and SERIES for scanning image series in NONSTOP or LIMITED sub-modes with possibility to accumulate and average the signal.
- High-speed scanning in several SEARCHING modes (full image scanning with different binning) and then in the ROI mode (Region Of Interest scanning of image's region without binning).
- TimeLapse: fully automatic execution of the prepared scanning session.

### **Correction & Preprocessing**

- Automatic BACKGROUND subtraction and FLAT-FIELD correction on scanning.
- Intuitive and fully automatic wizard for preparation of background and flat-field reference images.
- Automatic background interpolation on exposure change.
- "on scan" FFT (Fast Fourier Transform) and automatic acquisition of image NEGATIVE.
- Automatic correction of BAD PIXELS on scanning: single pixels, rows and columns of pixels.
- Automatic horizontal, vertical and diagonal FLIP and central ROTATION of images on scanning.

# Storage & Viewing

- Multi-BUFFER for images and image series with preview and unrestricted size.
- Multifunctional IMAGE-WINDOWS for image viewing; multiple and single image-window modes.
- Static and dynamic contrast modes for image display; slide show.
- ZOOMING in and out the whole image plus MAGNIFIER displayed in the separate window.
- Variety of HISTOGRAM manipulations for image display adjustments.
- AXONOMETRY: three-dimensional representation of the image with coloring.
- COLORING of monochrome images using default and user-defined LUTs (look up tables).

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From left to right: Fourier Analysis window, power part of FFT of the image with blob tools, Axonometry: 3D representation of the image.

#### **Calibration & Measurements**

- METRIC CALIBRATION: calibration of space, Fourier and diffraction images.
- Drawing SCALE, rulers, overlays with graphs; text, flag and arrow MARKERS.
- Measurements using variety of METRIC TOOLS: line, linestripe, rectangle, polygon, polyline, circle, sector, ellipse, grid, color grid, double circle and blobs (for FFT or diffraction mode).
- Easy and fast calculation of extensive image STATISTICS: Min, Max, Sum, Average, RMS etc.
- Estimation of similarity and relative shift of two images via 2D CROSS CORRELATION.

#### Image Processing & Analysis

- CONTRAST and BRIGHTNESS adjustments via histogram manipulations;
- Mathematical analysis of images: 1<sup>st</sup> and 2<sup>nd</sup> order DERIVATION and INTEGRATION;
- Color levels adjustments for color images using COLOR BALANCE;
- Image FILTERING: edge detection, sharpening, smoothing, thresholding, averaging, white balance etc.;
- GAMMA CORRECTION using correction curves;
- Frequency filtering of images via FOURIER ANALYSIS: low, high, band and blob pass and stop filters;
- Display of the MTF (modulation transfer function) curve;
- Image mathematics: ARITHMETIC, TRIGONOMETRIC, MIXING and OVERLAY operations;
- SHADING CORRECTION of images via lowpass filtering or light plane fitting;
- Image TRANSFORMATIONS: scaling, rotating, flipping, padding, cropping, conversions etc.

### **Image Collections & Report Generation**

- Structured storage of images, accompanying information and related documents as DATABASES;
- Creation of image GALLERIES as structured collections of images and their info;
- Parameterized SEARCH for images in specified folders and their subfolders;
- Copying full image INFO, statistics and measurements to Excel, Word, WordPad and Text Editor;
- Arranging the image document before PRINTING; printing several images with tools; print preview;
- The WATERMARK functionality which allows to burn necessary text on the image permanently.

### Data Types & File Formats

- Supported image data types: monochrome 8, 16, 32 and 64-bit, RGB 24 and 48-bit;
- Easy conversion of images between different data types;
- The default file format is TIFF: it allows to save single images and image series plus image info;
- Main image file formats: monochrome and RGB TIFF, raw image format, BMP, JPEG, GIF;
- About a hundred of recognized image file formats: for the most the saving operation is supported;
- Animation with saving into \*.AVI files.

### Graphs & Spectra

- Reading of SPECTRA from different metric tools on the image: cursor, line, linestripe etc.;
- Calculation, processing, saving and loading of graphs and spectra; special BUFFER OF GRAPHS;
- Automatic search of PEAKS on graphs plus extensive peaks statistics.

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From left to right: Panorama window with aligned images, ESI application of EFTEM, list of particles in Analyze Particles.

# Additional optional modules of ImageSP

### Panorama

The Panorama module allows to align and stitch together series of partially overlapping images and contains tools for scanning of such image series. Via scanning and displaying the transmitted images directly in the Panorama window, wide areas of a specimen can be covered and represented as a series of overlapping fragments. These fragments can be aligned and stitched together into an equalized panorama, which can be stored as a single image. Scanning can be performed with (for Carl ZEISS TEMs only) and without using the automatic Image Shift System or goniometer, either of which should be properly calibrated.

- Calibration of the image shift system or goniometer;
- Scanning of series of overlapping images with and without using the automatic shift system;
- Scanning of images for panorama construction in normal and search scan modes;
- Aligning and stitching series of overlapping images into a single big panoramic image;
- Equalization of the whole panorama and grey leveling of brightness on borders of connected images.

### EFTEM

EFTEM (Energy Filtering Transmission Electron Microscopy) is an analytical technique that makes use of the characteristic electron energy loss in solids. ImageSP EFTEM module consists of three applications: ESI, IEELS and PEELS, which represent three EFTEM methods. The ESI (Energy Spectroscopic Imaging) method allows to acquire a highly resolved element distribution image of your specimen. The IEELS (Image Electron Energy-Loss Spectroscopy) application allows scanning series of images at different energy-loss values. IEELS series can be used to generate spectra or element-distribution images. The PEELS (Parallel Electron Energy-Loss Spectroscopy) method allows to acquire spectrum of a specimen for calibrated range of energy-loss values and to perform wide range acquisition. EFTEM software also includes periodic table of elements together with the library of EELS atlases and ionization edges schemes.

- Acquisition of ESI image sets for different background approximation methods;
- Acquisition of an IEELS series with predetermined energy increment;
- Acquisition of the High Contrast Image (HCI);
- Scanning in fast search mode before final acquisition of images in ESI and IEELS;
- Drift correction of acquired images in ESI and IEELS;
- Generation of spectra from user-defined image regions in IEELS;
- Calculation of background and element-distribution images in ESI and IEELS;
- Filtering and coloring of the element-distribution image to produce colormap in ESI and IEELS;
- Overlaying and stitching any base image, for instance HCI, with colormap in ESI and IEELS;
- Mapping of ESI series from an IEELS series; processing of the mapped ESI series;
- In PEELS: spectrum calibration for current values of High Voltage and Spectrum Magnification;
- In PEELS: performing the zero-point calibration;
- Acquisition of a single spectrum for selected element in PEELS;
- Wide range acquisition for specified range of energy-loss values in PEELS.

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#### TRS & SYSPROG



From left to right: Distribution of particles into classes in Analyze Particles, the image with detected particles colored according to their class, diffraction pattern with indexed reflexes after matching in Diffraction Analysis.

### **Analyze Particles**

The Analyze Particles module is intended to highlight particles (groups of pixels) in the image, satisfying the specified brightness and shape parameters, as well as to obtain the statistical characteristics of these particles. The user can edit found particles, remove some of them and create new ones.

- Defining the brightness range of image pixels, among which the detection of particles will take place;
- Detection of particles on both single image and multiple images;
- Variety of particles manipulations: division, addition, merging, brushing, deletion etc.
- Displaying the distribution of the detected particles with respect to the selected parameter;
- Distribution of the detected particles into classes; adjustment of particles in classes;
- Generation of reports with statistics of particles and their classes;
- Sending reports to Excel, Word; preparation of the report for printing plus print preview.

### **Diffraction Analysis**

The Diffraction Analysis module provides means to index single crystal electron diffraction patterns and, provided a crystal data database for studied materials is available, perform main and additional phase identification. For user convenience, a crystallographic calculator capable of computing interplanar distances, interfacial and interdirectional angles is provided.

- Detection of the zone axis and indexing the reflexes of a diffraction pattern for a known crystal;
- Testing hypotheses about the chemical compound of the sample used to obtain the diffraction pattern;
- Calculation of interplanar distances and interdirectional and interfacial angles for given crystallographic planes in a crystal with a specified unit cell;
- Calculation of the parameters of the corresponding reciprocal cell and the volume of the unit cell;
- Creation of new or deletion and editing of the existing crystallographic databases;
- Performing manual identification of reflexes when there are many reflexes on the diffraction image.

### **Script Engine**

The Script Engine is a tool for recording your actions in ImageSP in a form of a script. The script can be then played, thus reproducing all the recorded actions fully automatically or with minimal user interaction. In essence, the script is a list of commands to ImageSP. The scripts can be recorded, played, edited, created from scratch, saved and loaded.

- Recording user actions in ImageSP in a form of a script, which is recorded with timings;
- Editing recorded scripts and creation of new scripts from scratch;
- Variety of predefined easy-to-use script functions and operators;
- Playing the scripts with and without timings, step by step and continuously;
- Saving scripts as XML, RTF and TXT files and loading scripts from them;
- Adding to scripts comments, loops, labels, comparisons, pauses, stops and different kinds of messages;
- Performing searching within the scripts and viewing a second script as a help script.



From left to right: Drift Correction Wizard on the Check Drift step, Periodic Table in EFTEM.

# **Drift Correction**

The Drift Correction Wizard of ImageSP is intended for alignment of multiple images of the approximately same area with a single reference image. The wizard allows to: calculate drifts of several shifted images with respect to one reference image, investigate the difference images, check the drifts and change them manually, and align the shifted images.

