IMA-Microlead®Analysis

IMA-TechSheet #104140 V1

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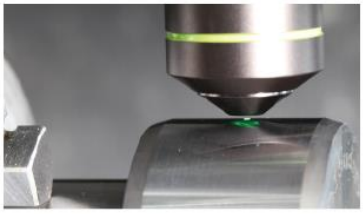
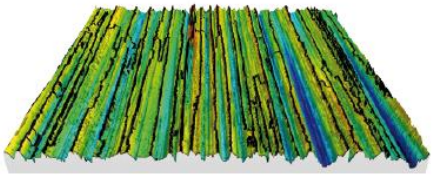
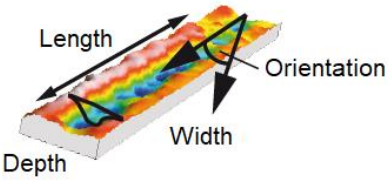
1. Measurement



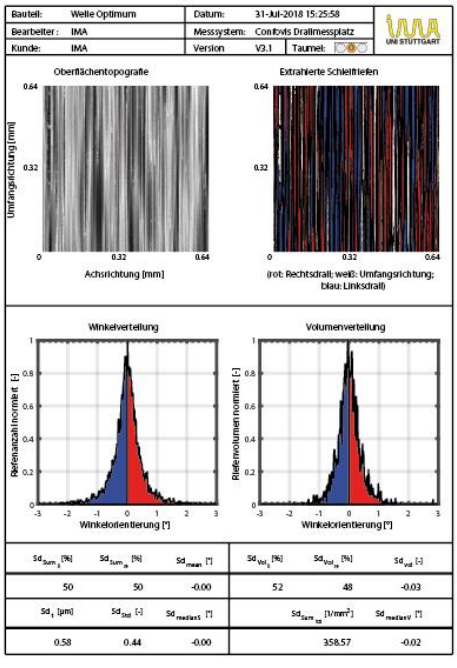
2. Filtering + segmentation



3. Characteristic extraction



4. Statistical analysis



IMA-Microlead®Analysis - Measuring procedure

Description:

IMA-Microlead®Analysis is a structure-based, quantitative evaluation method in which the sealing counter-surface is evaluated with regard to the grinding grooves (micro-lead) on it. In order to achieve this, high-resolution 3D surface topographies acquired by optical topography measuring devices are evaluated using digital image processing methods. In order to achieve precise and statistically profound measured values and to compensate for a potential tumbling error of the component clamped in the measuring device, a defined measuring grid with several individual measurements in axial and circumferential direction is carried out around the entire circumference of the component. The alignment of the component to be measured in the coordinate system of the measuring device is algorithmically compensated here using the determined measurement data.

The evaluation of the acquired 3D topographies can be roughly divided into the following analysis steps:

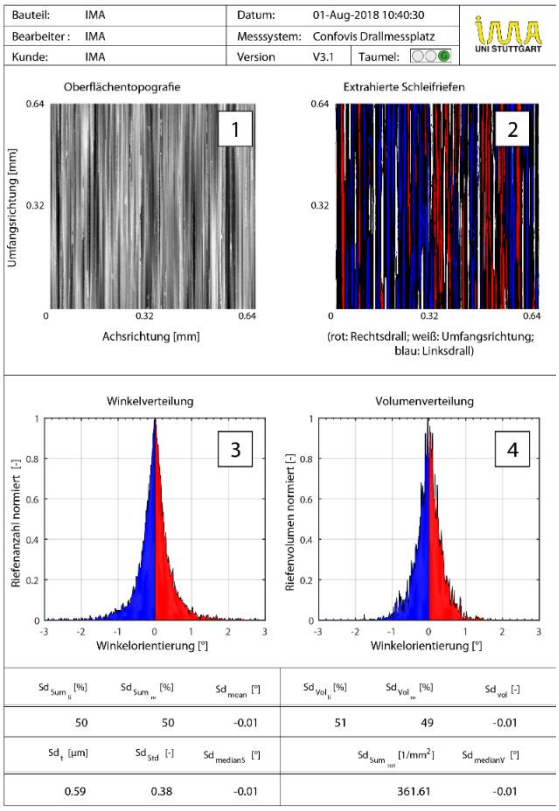
1. High resolution measurement
2. Topography filtering and segmentation of the grinding grooves
3. Determination of size, position, angular orientation and volume of the grinding grooves
4. Statistical evaluation of the data and determination of distribution curves and characteristic values and presentation in the form of a protocol

Available Measuring Devices:

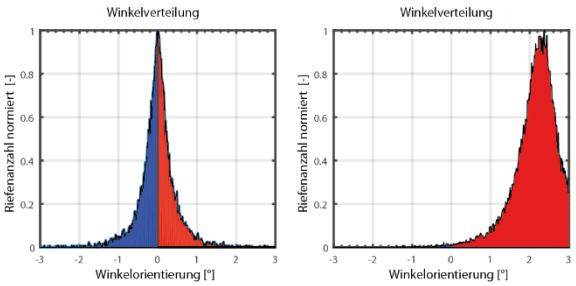
- Confovis surface and lead measuring station
- Bruker NPflex-LA

Explanation of the Measuring Protocol:

The protocol of the IMA-Microlead®Analysis is shown on the right. The protocol header contains information such as the component name, the date of evaluation and the type of measuring system. A three-step traffic light indicates the quality of the chucking of the measured componentMeasurements with red traffic light signal should be repeated with improved chucking. A further component of the protocol is a greyscale representation of the topography in plan view **(1)**. **(2)** represents the binarized topography in which the individual recorded grinding grooves can be recognized. The color code indicates the orientation of the grinding grooves. **(3)** shows the angular distribution of all detected grinding grooves. For this purpose, the number of all grinding grooves oriented in a certain angular position is summed up and plotted over the angular orientation. The zero degree position indicates the circumferential direction of the measured component. In **(4)** the volume distribution is shown. Similar to the angular distribution, here the volume of rectified grinding grooves is cumulated and applied over the angular position.



Measuring protocol IMA-Microlead®Analysis



Distribution curves of a suitable (left) and unsuitable (right) seal counter surface with regard to micro-lead

An ideal seal counter surface has symmetrical and circumferentially oriented distribution curves. Whether a micro-left or micro-right-lead is present can be recognized by a shift, uneven distribution or asymmetry of the distribution curves. On the right, the distribution curve of a counter surface suitable for use as a seal counter surface and a leaded and therefore unsuitable counter surface are shown as examples.

Micro-Lead Characteristics:

Percentage of right- / left-handed micro-lead structures $Sd_{Sum,li}$, $Sd_{Sum,re}$

The parameters $Sd_{Sum,re}$ and $Sd_{Sum,li}$ represent the percentage sums of all positive and negative oriented micro-lead structures of the angular distribution curve WV.

$$Sd_{Sum,re} = \int_{0,01°}^{90°} WV(\gamma)$$
$$Sd_{Sum,li} = \int_{-90°}^{-0,01°} WV(\gamma)$$

Percentage share of right- / left-handed structure volume $Sd_{Vol,li}$, $Sd_{Vol,re}$

The parameters $Sd_{Vol,re}$ und $Sd_{Vol,li}$ re the percentages of the positively and negatively oriented cumulated structural volume of the angular volume distribution WVV.

$$Sd_{Vol,re} = \int_{0,01°}^{90°} WVV(\gamma)$$
$$Sd_{Vol,li} = \int_{-90°}^{-0,01°} WVV(\gamma)$$

Median angle of the angular distribution and the angular volume distribution $Sd_{median,S}$, $Sd_{median,V}$

The parameters $Sd_{median,S}$, $Sd_{median,V}$ are the median values of the angular and angular volume distribution. I.e. they indicate the angular orientations, for which the number of larger and smaller angles or angular volumes is equal.

$$Sd_{median,S} = median(WV(\gamma))$$
$$Sd_{median,V} = median(WVV(\gamma))$$

Arithmetically averaged micro-lead depth Sd_t

The parameter Sd_t is the arithmetic mean value of the structure depths t of all detected micro-lead structures n.

$$Sd_t = \frac{1}{n}\sum_{1}^{n} t(n)$$

Standard deviation of angular orientations Sd_{std}

The standard deviation Sd_{std} is used as a statistical measure for the occurring scatter of angular orientations of all detected micro-lead structures. It describes the width of the angular distribution curve and is derived from a Gauss curve fitted to the normalized angular distribution.

$$Sd_{std} = std\big(WV(\gamma)\big)$$

Number of micro-lead structures per mm^2 $Sd_{Sum_{tot}}$

The parameter $Sd_{Sum,tot}$ is the number of micro-lead structures detected on a measuring surface of $1\ mm^2$.

$$Sd_{Sum,tot} = \frac{\sum n}{1\ mm}$$