Measurement Science & Standards in Forensic Firearms Analysis

Measurement Science Advances in Firearms Analysis

Focus Variation
Brad Etter
Alicona
July 10-11, 2012
Focus-Variation
Focus-Variation as a Measurement Technique
Information at each Measurement Point

» 3D-Position \((x, y, z)\)
» Color \((R \ G \ B)\)
» Est. Repeatability
Measure Form and Roughness with one Instrument

Form & Roughness
Benefits of Focus-Variation

Form and roughness in one measurement

- Rough and smooth surfaces
- Color information
- Steep flanks
- Diversity of materials
- Large measurement areas
- Ease of use
Focus-Variation Technical Specifications

Optical 3D-surface metrology based on a color focus sensor

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical resolution</td>
<td>&gt;10nm</td>
</tr>
<tr>
<td>Lateral resolution</td>
<td>&gt;400nm</td>
</tr>
<tr>
<td>Scan height</td>
<td>&lt;22mm</td>
</tr>
<tr>
<td>Scan area</td>
<td>100mm x 100mm</td>
</tr>
</tbody>
</table>

Surface measurements in less than 16 sec.
(2 million measurement points)
Where Focus Variation Fits

- **Focus-Variation**
- **Structured Light**
- **Confocal**
- **WLI**

Resolution vs. Measurement Volume

- **Resolution**
  - 1nm
  - 10nm
  - 100nm
  - 1µm
  - 10µm
  - 100µm
  - 1mm

- **Measurement Volume**
  - (10µm)^3
  - (100µm)^3
  - 1mm^3
  - (10mm)^3
  - (100mm)^3
  - 1m^3
50X Objective
Vertical Resolution: 20nm
Number of Points: 10million
Size of ImageField: 2.66mm x 1.80mm
Profile Form Measurement

Profile path: 50x objective, realcolor.
Profile width 8.8µm

Measurement Depth    Width
[1] Rifling   0.8µm   12.2µm
[2] Rifling   1.6µm   15.3µm
[3] Rifling   1.5µm   12.4µm
Firing Pin

- Objective 10x Size of measurement point 880nm
- Vertical resolution 800nm
- Number of points 3.7 million
- Size of ImageField 2.68mm x 1.08mm
Firing Pin

Depth 699.9µm
Measuring Real3D-Data

Specimen

Measurement Area 1
Measurement Area 2
Measurement Area 3
Measurement Area 4
Measurement Area 5
Measurement Area 6
Measurement Area 7
Measurement Area 8

©Alicona
Optical 3D micro coordinate measurement | Form & roughness
Measurement results contour analysis – Circle fitting

- Radius: 3.919 mm
- Surface: 48.25 mm²
- Maximum deviation: 82.17 μm
- Mean deviation: 35.797 μm
Roughness: Profile VS Area
Roughness-Profile Based

- Ra 86.029 nm
- Ra 559.06 nm
Roughness- Area Based

» Sa 582.79 nm
Core Surface Volume

Vresp: peak material volume
Vve: core void volume
Vmcr: core material volume
Vvvr: valley void volume

Max. height

Peak area

40% of minimum slope

Valley area

Min. height

Rpk
Rk
Rvk

Mr1
Mr2

0%
100%
Difference Measurement
Difference Measurement
Measurements include...

» **Roughness** measurements
  - Profile based
    4287, ...
  - Area based
    ISO 28178, corrosion, ...

» **Form** measurements
  Diameter, sink hole measurement, roundness ...

» **Orientation** measurements
  Distances, geometries, ...
Focus-Variation provides...

» Up to 100 Mil. 3D-points
» Across an area of 100x100mm
» **Vertical scan range** of 100mm (at 23mm working distance)
» Full 360°
» **The largest variety of materials** (solid)
» Resolution of up to 10nm
» **Data Export**: .STL, TEXT, VRML, .SUR, OpenGPS
Focus Variation

Form and Roughness in One System