

Preparation of test samples

1. Sampling point

The sampling must be adapted to the investigation purpose. Structure-oriented parts must be differentiated with the sampling between transverse cross section, along and even grindings. The structure may not be changed by the sampling. So the sample heating up is to be kept as small as possible with mechanical separation by application of suitable cooling agents.

1) CUTTING-OFF

small wet-cut-off-machine (Mesotom- company Struers)

application: to cut-off small hard and soft workpieces

capacity for cut-off: 90mm Ø, 120 x 40mm

**Technical data:**

engine 3 x 380-420V, 50Hz, 3,2kW

dimensions & weight:

width: 651mm

depth: 645mm

height: 410mm

weight: 80kg

Automatic large wet-cut-off-machine (Exotom 100- company Struers)

application: to cut-off large hard and soft workpieces

capacity for cut-off: 160mm Ø

up to 300mm cut-depth

**Technical data:**

engine 3 x 380-415V, 50Hz, 10,5KW

water connection

water drain

dimensions and weight:

width: 1050mm

depth: 1500mm

height: 1756mm

weight: approx. 820kg

Precision cut-off machine (Accutom-5-R, company Struers)

application: for precision cut-off machine on hard, soft and sensitive workpieces

precision of 5µm

Capacity of cut-off: max. 100mm Ø

**Technical data:**

engine 1x 220-240V, 50-60Hz, 370W

dimensions and weight:

width: 510mm

depth: 700mm

height: 300mm

2. Set in - an embedding of the samples

For better handling and/or to the edge protection the samples are set in or embedded.

Methods:

- A. Clamp in cross section owners
- B. embed in plastic (cold or warm embedding) or into other materials (metal alloys)
- C galvanic embedding (in particular to the edge protection)

Rotax uses mainly the method b) warm embedding - here a shrink-poor embedding means should be used around, to receive no gap between sample and embedding means. A gap between sample and embedding means is bad with measurement on small shifts and/or edge structure evaluations (edge oxidation etc.)

2) EMBEDDING

ProntoPress – 20 (company Struers)

Automatic electro-hydraulic warm-embed-press with micro-process-control for the simultaneous operation of two embedding-entities

application: embedding of samples



<p>Technical data: 220V, 6A water connection water drain dimensions: width: 420mm depth: 600mm height: 550mm</p>
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3. Grinding

For the visible making of the structure a polished surface is necessary. For this the surface becomes carefully gradually polished, whereby a possibly existing deformed layer (partially) is cleared away.

Grinding takes place by hand with sandpaper, which lay upon an even plate or a turntable. The first sharpening step is normally made with sandpaper of the number 180 and/or at the grinding machine, used afterwards sandpapers of the numbers 220, 320, 400 and 800. After each grinding step, the sample is turned around 90° and in the same sharpening direction further-polished. Thus the grinding scoring of the before used paper is eliminated.

Because of the danger of inadmissible heating up the metal sample may not be pushed too strongly on the grinding disk. The lubricating and coolant should clean at the same time the grinding paper and the sample of broken out emery.

3) GRINDING

Large grinding support

application: for rough-grinding



Technical data:
380V / ~ 4,5kW
dimensions:
width: 1430mm
depth: 1000mm
height: 1500mm

two-spindle wet-grinding machine (LaboPol-21- company Struers)

application: rough-grinding of samples

used granulation: 220 / 320 / 400 / 800



Technical data:
220V, 180W, 5A
water connection
water drain
dimensions :
width: 700mm
depth: 700mm
height: 220mm

4. Polishing

During polishing the rest of rills from grinding will be removed as well as a possibly still existing thin deformation layer (far) is cleared away.

On velvet - or wool-clothings laid on dredged alumina (Al_2O_3), magnesia Usta (MgO), polishinggreen (Cr_2O_3), crocus (Fe_2O_3) or almost exclusively diamond paste serves as polishing agents. The elasticity of the polishing cloths affects the polishing quality. Polishing with a smooth cloth will bring a good surface without rills.

The edges round more or less off, also is to be counted on scoring formation by clearing away soft non-metallic inclusions. By polishing with a harder cloth the rounding of edge and relief formation can be avoided rather, however the surface is not absolutely scratch-free. Polishing cloths are lubricated during the polishing process with distilled water or when using diamond pastes with oil and petroleum.

In the polished condition you can see already non-metallic inclusions, like carbides, sulfides or oxides in the steel, graphite in the grey cast iron, or irregularities, like pores, tears, pipe, among other things, but no structure, under the microscope

4) POLISHING

Automatic polishing-system with sample-mover and (metering) system

application: for automatic production of polished specimen (single resp. max 6 samples)

disc diameter: max. 300mm



Technical data:
380V, 4,5A (max.)
water connection
water drain
air pressure
dimensions:
width: 1000mm
depth: 750mm
height: 700mm

5. Etching

To a structure development etching is necessary. When the chemical attack of the etching agent on those different structural constituents on their orientation and chemical composition depends, the reflection behavior of the structural constituents is changed in such a way that a clear distinction becomes possible. The etching agents and etching times suitable for the different materials were empirically determined.

In order to prevent a strong attacking of the surface by etching agent, it is diluted e.g. with alcohol, glycerin or glycol. With etching agents, which attack, color or hurt the skin, the samples are dipped by a piler out of steady material, like rustproof steel and nickel, into the etching agent. Afterwards the sample with water and alcohol is rinsed off, dried in warm air thoroughly and regarded under the microscope.

In the following board the most well-known and/or most common etching agents are indicated, see also indicated

Literatur.

Nr	Name and composition of the etching agent	Purpose
1)	Nitric acid (Nital): 1 ml nitric acid HNO ₃ 1.4, 100 ml alcohol (ethyl o. methyl)	for iron, grey cast iron, low alloyed steel, high-speed steels for the development of the small structure as well as suitably for the determination of the nitrated layer.
2)	Pikrin acid (spades ral): 4 g Pikrin acid HO ₂ C ₆ H ₂ (NO ₂) ₃ 100 ml alcohol (methyl o. ethyl)	Like point 1
3)	V2A-Beize 10 ml nitric acid 1.4 0.30 of bird saving spickles 100 ml hydrochloric acid 1.19 100 ml dest. Water	particularly suitably to the development of the structure with high chrome content rustproof steel and with high-speed steels as well as for the development of the grain size in the martensitic structure. Grain boundary corrosion for austenit CR-Ni-steel
4)	Cellar Wilcox 5 ml hydrofluoric acid 40%ig (HF in H ₂ O) 15 ml hydrochloric acid 1.19 24 ml nitric acid 1.40 955 ml dest. Water	Development of the small structure with pure aluminium and aluminium alloys
5)	10 g copper ammonium chloride 120 ml dest. Water as much ammonia (NH ₃) add, until the developing precipitation separates again.	Development of the small structure of copper, off brass, red brass bronze, aluminum bronze and architectural bronze

5) CAUTERIZATION

Extractor cabinet

application: for production of acids resp. cauterization of samples



Technical data:

220V / Abluft E-Motor

dimensions and weight:

width: 1200mm

depth: 800mm

height: 2700mm

weight:

water connection

water drain

6) MECHANICAL EXAMINATION

Hardness Testing Set UH250 (company Reicherter / Stiefelmayr)

application: Hardness Testing

test procedure: Vickers, Brinell, Rockwel



Technical data:

220V, 50/60Hz, 0,5KVA

dimensions and weight:

width: 350mm

depth: 680mm

height: 975mm

weight: ca. 230kg

Digital-Light-load hardness test equipment (Emco-Test M1C 100)

application: manual hardness testing resp. full-automatic evaluation
(Eht/Nht-sequence plots) with inspection report

test procedures: Vickers: HV0,1 – HV30

Knoop: HK0,1 – HK1

Brinell: HB1/1 – HB2,5/31,25



Technical data:
110/220V, 50/60Hz
power input: approx 70VA, 140VA bei
motoric X-/Y-axis
dimensions & weight:
width: 240mm
depth: 435mm
height: 700mm
weight: ca. 35kg

G) MICROSCOPE

Reflected-light microscope (Olympus BX60) with picture-analysis system

application: metallographically microstructure verification – measuring of layer thickness
picture editing

Enlargement (zoom): 50x – 1000x



Technical data:
220V, 5A + 1PC 220V
dimensions:
width: 300m
depth: 600mm
height: 750mm