



University of Stuttgart
Germany

Institute for Metal Forming Technology Equipment Directory

2020-21



University of Stuttgart
Institute for Metal Forming Technology
Univ.-Prof. Dr.-Ing. Dr. h. c. Mathias Liewald MBA

Holzgartenstr. 17
70174 Stuttgart
Germany
www.ifu.uni-stuttgart.de

IFU

Introduction

Who we are?

The Institute for Metal Forming Technology (IFU) is a research institute of the University of Stuttgart and is in close contact with the automotive industry and suppliers in South Western Germany.

Capabilities

The key challenge that the Institute for Metal Forming Technology addresses is the need for new process technologies in both bulk and sheet metal forming as well as digitisation in production processes.

The IFU houses over €5M worth of equipment, built to the researcher's specifications. The IFU can heat, shape, and analyse metal parts in-house.

Strategy

The IFU's focus on highly sophisticated metal forming processes is based on the need for current and next generation manufacturing methods which can produce metallic parts to the highest standards of structural integrity.



Index

Cold and hot forging capability

Schuler 500 Tons Knuckle Joint Press	5
MAY 600 Tons Mechanical Press	6
SMG 600 Tons Hydraulic Press	7
Becker & van Hüllen 500 Tons Hydraulic High-Speed Press	8

Sheet metal forming capability

AIDA 500 Tons Servomechanical Press	9
Mueller 200 Tons Hydraulic Press	10
Bruderer 28 Tons High-Speed Blanking Press	11
Trumpf TruPunch 5000R 22 Tons Punching Machine	12
Mueller Weingarten 3500 Tons Hydroforming Press	13

Materials characterisation capability

Dynamic Systems Gleeble 3800c Material Testing Machine	14
Roell + Korthaus RKM 100 Material Testing Machine	15
Nakajima Testing Setup	16
Universal Rheometer MCR 501 Anton & Paar	17
Fischer Micro Vickers Hardness Tester	18
Wolpert Dia-Testor 2RC Macro Hardness Tester	19

Metallographic preparation

ATM Brilliant 250 Cutter	20
ATM SAPHIR 550 / RUBIN 520 Grinder / Polisher	21
ATM OPAL 480 Hot Mounting Press	22

Metrology capability

GOM ATOS Compact Scan 5M	23
Keyence Digital Microscope VHX-5000	24
Zeiss Observer. D1m Optical Microscope	25
Zeiss Universal Form Tester RONDCOM NEX	26
GOM Argus	27
Nanofocus µSurf	28
Fischer Fischerscope Film Thickness Tester	29
Thermal Imaging Camera	30

Index

Furnace and handling capabilities

Nabertherm Furnace LF 15/14-S	31
Nabertherm Furnace N500/85HA	32
Induction Heating System KUKA	33
Kawasaki RS010L Robot	34

General machine tool capability

Kekeisen Bed Milling Machine	35
DMG Universal Milling Machine	36
Spinner CNC Turning Center	37
Trumpf TruShear 3103 Hydraulic Shear	38
Wire Drawing Machine	39
Felss FR16 Rotatory Swaging Machine	40
Teschauer Laser Labeling Machine	41
Abrasive Blast Cabin MHG SMG 50	42

Cold and hot forging capability

Schuler 500 Tons Knuckle Joint Press



Purpose

The Schuler MSL 1-500-0,85-500 is a servo-mechanical cold forging press for typical single station cold forging processes featuring Schuler Servo-Drive technology which allows user control of press stroke. It is a direct drive vertical knuckle joint press with two servo drive motors providing loads up to 5000 kN, and features for both ram and press table hydraulic ejectors.

Specifications

- Vertical cold forging press driven by 2 servomotors
- High-performance servomotors enable programming of diverse ram speed profiles and stroke sequences
- Upsetting capacity of ram: 5000 kN
- Vertical ram stroke: 500 mm
- Stroke speed: 3 – 45 1/min
- Table ejector stroke: 125 mm
- Minimum distance ram – table: 1048 – 1060 mm
- Ram position adjustment: 12 mm
- Table dimension: 850 mm x 800 mm (width x depth)

Cold and hot forging capability

MAY 600 Tons Mechanical Press



Purpose

The MAY MKN2-600/14 is a mechanical cold forging press for typical single station cold forging processes featuring an automation system for workpiece transfer. It is a vertical crank press providing loads up to 6000 kN and a table ejector.

Specifications

- Vertical mechanical cold forging press
- Upsetting capacity of ram: 6000 kN
- Vertical ram stroke: 140 mm
- Stroke speed: 15 – 45 1/min
- Table ejector stroke: 70 mm
- Minimum distance ram – table: 370 – 420 mm
- Ram position adjustment: 50 mm
- Table dimension: 630 mm x 900 mm (width x depth)

Cold and hot forging capability

SMG 600 Tons Hydraulic Press



Purpose

The SMG HPZUI/300/300-1300/1000 is a hydraulic press used for sheet and bulk metal forming. Additional equipment such as a separate hydraulic power unit allows the use of multi-axes forming tools to investigate process control systems.

Specifications

- Single acting hydraulic press with programmable ejector system
- Type: HPZUI/300/300-1300/1000
- Ram force: 6000 kN
- Ejector force: 2000 kN
- Table dimensions: 1300 × 1000 mm (width x depth)
- Max. ram stroke 525 mm
- Max. ram velocity 160 mm/s
- Max. ejection stroke 350 mm
- Beckhoff-Control System extended with Plug-in modules for load, temperature sensors and digital/analog signals

Cold and hot forging capability

Becker & van Hüllen 500 Tons Hydraulic High-Speed Press



Purpose

The Becker & van Hüllen 500 Mp is a modified hydraulic high-speed press featuring a nitrogen piston accumulator which acts together with a hydraulic column controlled by proportional valves. The maximum ram speed is 800 mm/s. The press allows user control of press speed in dependence of ram position. The maximum force applied is 5000 kN.

Specifications

- Max. force: 5000 kN
- Max. ram speed: 800 mm/s
- Stroke: 300 mm
- Bed size: 900 x 900 mm
- Defined ram speed profile

Sheet metal forming capability

AIDA 500 Tons Servomechanical Press



Purpose

The Aida NST-S2-6300(D)-305-150-SERVO is a servomechanical single acting sheet metal forming press with a drawing cushion providing ram loads of up to 6300 kN. The press features the required equipment for the execution of continuous forming test trials. The servo-hydraulic drawing cushion allows energy recovery during deep drawing processes.

Specifications

- Servo-mechanical sheet metal forming press
- Max. ram force: 6300 kN
- Max. vertical ram stroke: 450 mm
- Drawing cushion force: 1500 kN
- Drawing cushion stroke: 250 mm
- Table dimension: 3050 mm x 1500 mm (width x depth)
- Max. stroke speed: 30 1/min
- Max. tool installation height: 1300 mm
- Ram position adjustment: 300 mm

Sheet metal forming capability

Mueller 200 Tons Hydraulic Press



Purpose

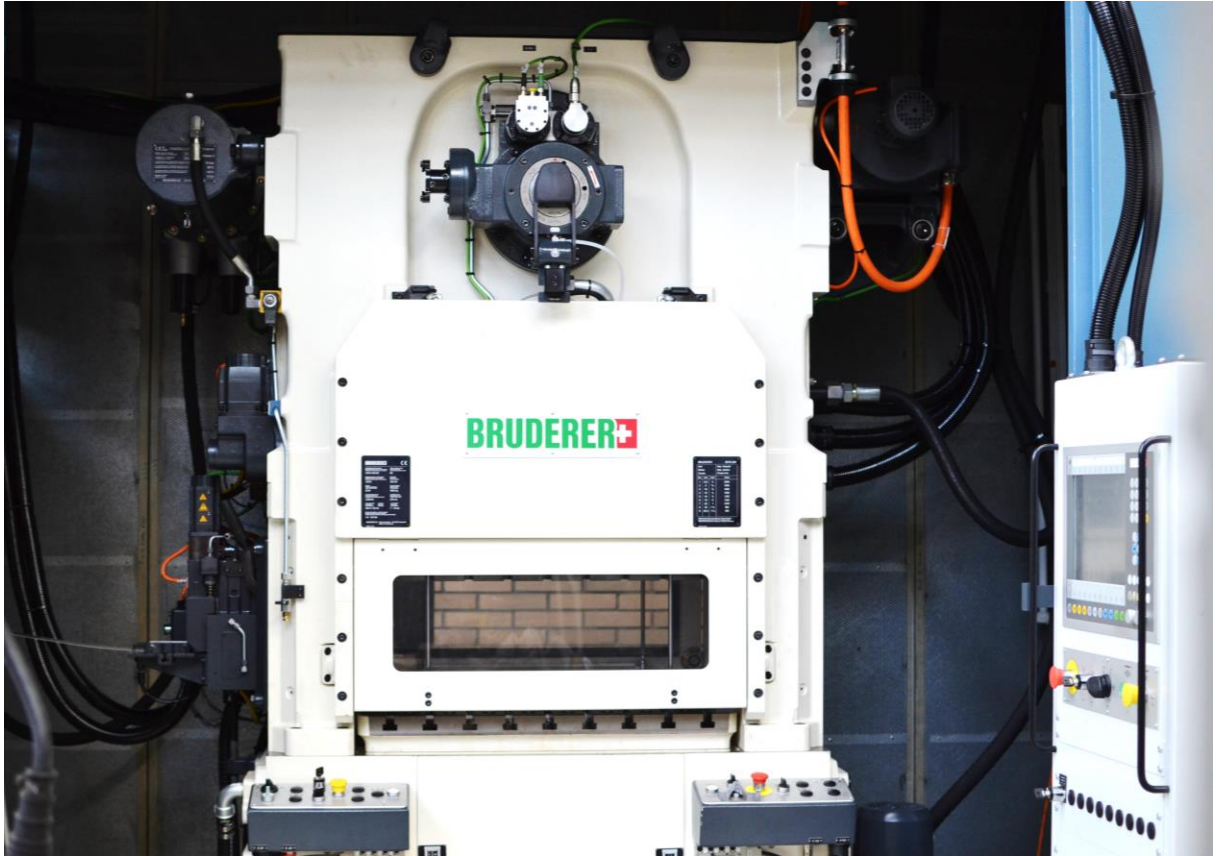
The Mueller Press is a hydraulic sheet metal forming and cold forging press for typical single station processes. It is a single acting press with a drawing cushion and provides ram loads up to 2000 kN. The hydraulic ejector provides forces up to 600 kN.

Specifications

- Hydraulic sheet metal and cold forging press
- Max. ram force: 2000 kN
- Max. vertical ram stroke: 800 mm
- Ram speed: 10 mm/s
- Table ejector stroke: 200 mm
- Ejector force: 600 kN
- Table dimension: 1000 mm x 1000 mm
- Max. tool installation height: 985 mm

Sheet metal forming capability

Bruderer 28 Tons High-Speed Blanking Press



Purpose

The Bruderer BSTA 280-88B2 is a mechanical high-speed blanking press for typical single- or multistage stamping processes. It is a single acting press which provides loads up to 280 kN.

Specifications

- High-speed sheet metal blanking press
- Max. ram force: 280 kN
- Max. vertical ram stroke: 6.5 mm - 40.5 mm
- Stroke speed: 100 – 2000 1/min
- No table ejector available
- Table dimension: 870 mm x 536 mm (width x depth)
- Max. tool installation height:
171 mm (40.5 mm stroke) – 239 mm (6.5 mm stroke)
- Ram position adjustment: 51 mm

Sheet metal forming capability

Trumpf TruPunch 5000R 22 Tons Punching Machine



Purpose

The Trumpf TruPunch 5000R is a hydraulic punching machine used for sheet metal working purposes.

Specifications

- Hydraulic punching machine
- max. sheet thickness: 8 mm
- max. punching capacity: 220 kN
- Stroke speed up to 1400 1/min
- Feeds: X 100m/min; Y 60 m/min
- Toolchanger with 7 tools
- Multi-tool available
- Max. sheet dimension: 1000 mm x 1000 mm
- Max. workpiece weight: 80 kg
- Control: Siemens Sinumerik 840D

Sheet metal forming capability

Mueller Weingarten 3500 Tons Hydroforming Press



Purpose

The Mueller Weingarten PIK 3500-24.1 1 is a hydraulic closing device for tube hydroforming with a plunger cylinder providing loads of up to 35000 kN. An external power unit provides hydraulic pressure for the hydroforming fluid as well as additional tool axes.

Specifications

- Hydraulic hydroforming press (closing device)
- Max. ram force: 35000 kN (closing force, plunger cylinder)
- Max. vertical ram stroke: 30 mm
- Ram force (movement of the closing device): 1000 kN
- Table dimension: 2500 mm x 900 mm (width x depth)
- Tool installation height: 670 – 945 mm
- Available adjustment plates:
 - 1 x 10 mm
 - 1 x 15 mm
 - 1 x 50 mm
 - 2 x 100 mm

Materials characterisation capability

Dynamic Systems Gleeble 3800c Material Testing Machine



Purpose

The Gleeble 3800c is a hydraulic machine used to study the mechanical behavior of metallic materials under compression, tensile and torsion loading conditions.

Specifications

- 3 modules for: Compression, tensile and torsion loading conditions
- Compression testing: Load up to 200 kN, ram velocity up to 2 m/s, heating temperature 1700 °C, heating rate up to 10,000 K/s, quenching device available, inert gas and vacuum chamber
- Tensile testing: Max. load 100 kN
- Torsion testing: Max. torque 100 Nm, quenching device available, inert gas and vacuum chamber

Materials characterisation capability

Roell + Korthaus RKM 100 Material Testing Machine



Purpose

Screw driven machine used to study the mechanical behavior of metallic materials under compression, tensile and cyclic loading conditions.

Specifications

- Screw driven test frame
- Load cell: 100 kN
- Strain rates: 10^{-5} to 0.5 s⁻¹
- Controlled in either a positional, load-controlled or true strain rate mode
- Bespoke software designed for complex testing modes involving rapid changes to the strain rate
- Tensile / compression testing
- Strain rate jump testing
- Stress relaxation testing
- MTS extensometer and GOM® Aramis for deriving the plastic strain ratio (r) value

Materials characterisation capability

Nakajima Testing Setup



Purpose

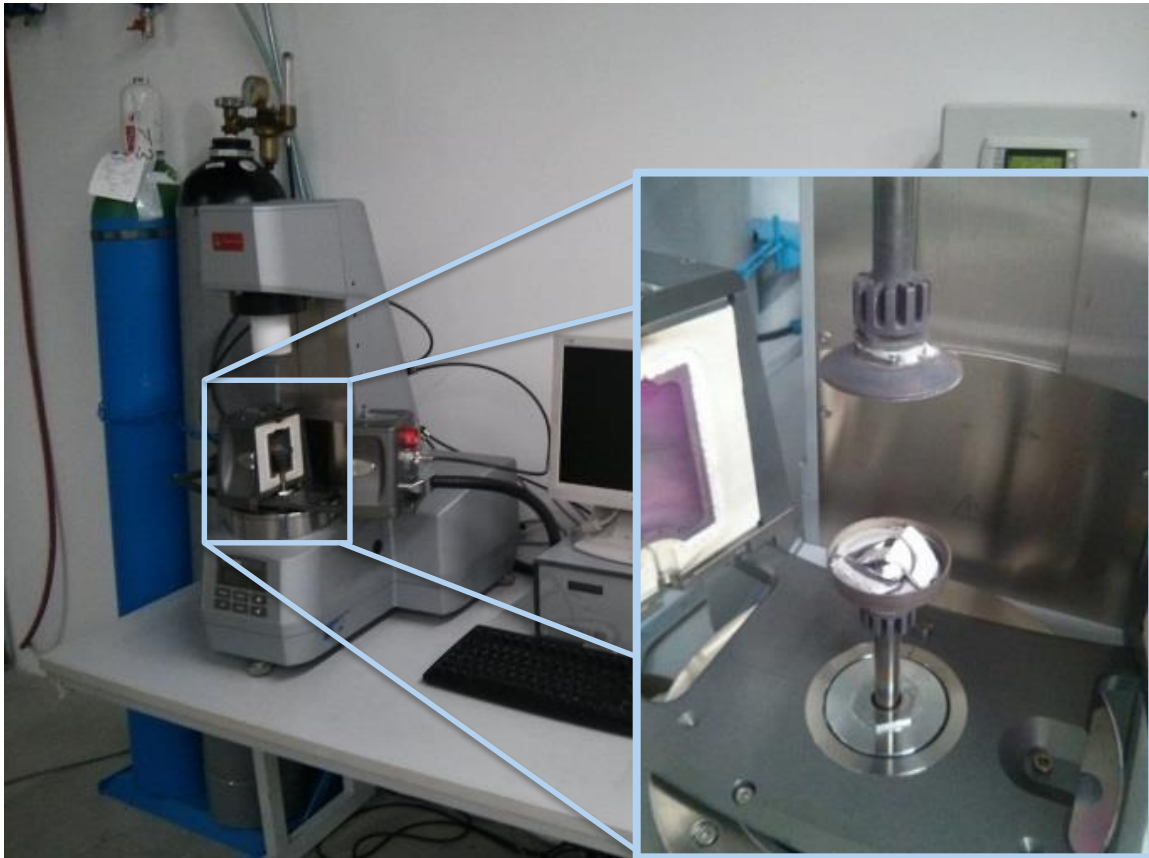
Hydraulic press with the installed tool and measuring equipment for performing Nakajima and Bulge tests.

Specifications

- Hydraulic press
- Press force: 160t
- Working speed up to 2.3 mm/s
- Approaching (closing) speed: 8,9 mm/s
- Punch diameter for Nakajima test: 100 mm
- Punch diameter for Bulge test: 100 mm

Materials characterisation capability

Universal Rheometer MCR 501 Anton & Paar

**Purpose**

The universal rheometer MCR 501 from Anton & Paar is used to define material behaviour in semi-solid state. It has several measurement options to define viscosity of the material. A high temperature chamber Typ CTD 1000 is used to heat the material up to the semi-solid state. Subsequently, a defined cooling can be set to measure viscosity over temperature curves.

Specifications

- High temperature chamber for temperatures up to 1000°C
- Controlled shear rate modus (CSR)
- Controlled shear stress modus (CSS)
- Plate-plate measuring system

Materials characterisation capability

Fischer Micro Vickers Hardness Tester



Purpose

Hardness testing of metallographic specimens.

Specifications

- Hardness testing on all materials using indenter technique
- Test load applied perpendicularly, without shock, and with defined application time and duration
- Max. testing load: 500 mN
- Instantaneous read-out of hardness
- Motor-operated table
- Microscope

Materials characterisation capability

Wolpert Dia-Testor 2RC Macro Hardness Tester



Purpose

Vickers/Brinell/Rockwell macro hardness testing of metallographic and non-metallographic specimens.

Specifications

- Macro hardness testing on all materials using indenter technique
- Test load applied perpendicularly with defined application time and duration
- Range of testing load: 1 kP to 250 kP
- Optical measurement of indentations and calculation of hardness values
- Various types of table inserts
- Height adjustable table offers possibility of testing large specimens

Metallographic preparation

ATM Brilliant 250 Cutter



Purpose

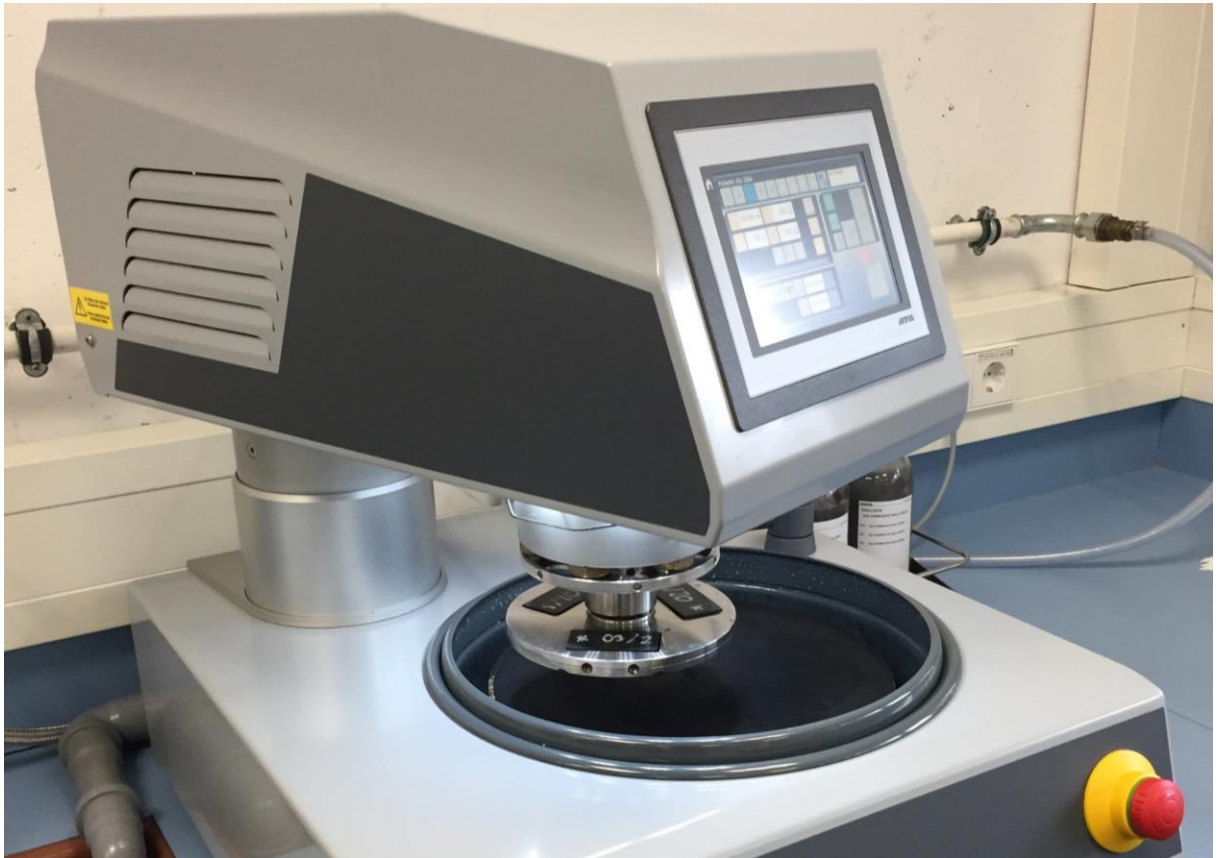
Used for sectioning larger specimens prior to metallographic preparation. Manual cutting action in 3 directions or automated cutting in one direction is possible.

Specifications

- Bench-top cutter for sample cutting and preparation
- Manual and automatic cutting action in 3 directions
- Four sectioning methods: Z-axis (140 mm) chop direction, X-axis (260 mm) serial section direction, Y-axis (180 mm) longitudinal direction, automatic Y-axis sectioning
- Wheel capacity: 356 mm (14")
- Touch-screen interface for all operations
- Maximum cut diameter 135 mm
- Motor power 4 kW

Metallographic preparation

ATM SAPHIR 550 / RUBIN 520 Grinder / Polisher



Purpose

Used to prepare high quality polished surfaces on a wide variety of metallographic materials for microscopy analysis. May be used in automatic or manual modes.

Specifications

- Grinding and polishing of metallographic samples
- Touch-screen control panel for Z-axis removal by depth
- Unique bowl shape for easy access to platens
- Multi-purpose water nozzle capability
- Platen cooling to minimize heat-build-up and reduce sample deformation
- Grinding wheel capacity \varnothing 200 – 300 mm
- Samples: up to 6 pcs. \varnothing 50 mm
- Specimen contact pressure: 20 – 400 N
- Rotation speed grinding wheel: 50 – 600 min⁻¹
- Rotation speed head: 30 – 150 min⁻¹

Metallographic Preparation

ATM OPAL 480 Hot Mounting Press



Purpose

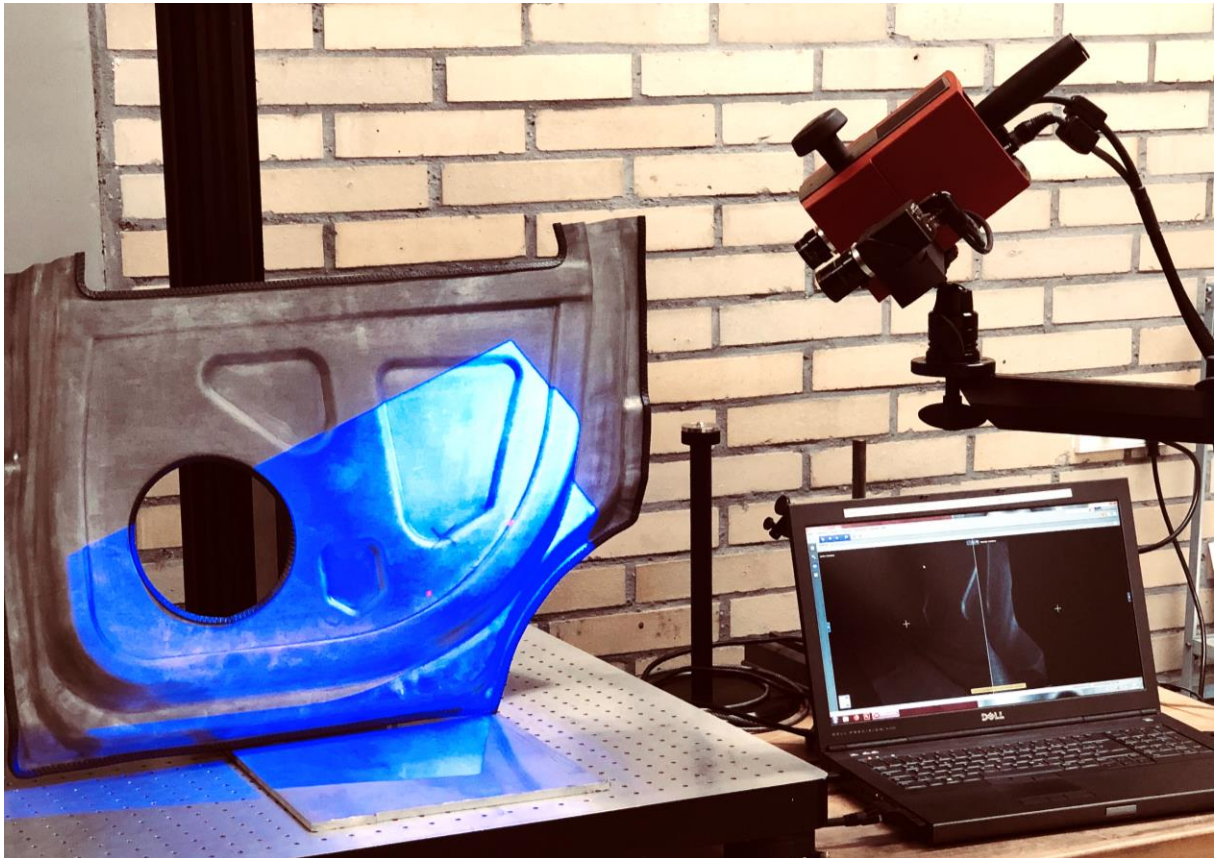
The OPAL 480 is a fully hydraulic, water cooled hot mounting press for mounting samples before polishing. The process sequence is executed automatically.

Specifications

- Fully automatic, electronic control
- LCD display with user interface
- Automatic water cooling
- Mould inserts easy to change
- Mould inserts: Ø 50 / 60 / 70 mm, Rectangular 30mm x 60mm and 40mm x 60mm
- Temperature range 20 – 220 °C
- Adjustable heating and cooling time
- Max. pressure: 310 bar

Metrology capability

GOM ATOS Compact Scan 5M



Purpose

The GOM ATOS Compact Scan 5M uses blue light technology to digitize fast and contactless various surface geometries. High resolution scans can be edited, reworked, measured and exported with associated software GOM Inspect. Comparison between nominal CAD model, evaluation of shape and dimensional accuracy with report generation or even reverse engineering are typical fields of application for GOM ATOS.

Specifications

- Blue light technology for fast measurements of various geometries
- reliable temperature range between +5°C to +40°C
- Mobile system with flexible clamping fixtures
- 2 x 5 000 000 pixels per scan
- Measurement volumes between 40 mm to 800 mm
- Working distance from 420 mm to 1170 mm
- Point spacing 0.02 mm to 0.3 mm

Metrology capability

Keyence Digital Microscope VHX-5000



Purpose

Digital optical microscope for the examination of experimental specimens. Material and hybrid compound characterization, fracture surface analysis, measurement of test samples, pore analysis, etc.

Specifications

- 3D Digital optical microscope
- Magnification: 20x up to 5000x
- Three objectives for different magnification ranges
- Three-dimensional imaging
- Multi-shot images
- Precise measurements
- Image analysis tool: (e.g for Pore Analysis)
- Automatic table movement
- Motorized Z axis for automatic height adjustment
- Camera resolution: 54 million pixels

Metrology capability

Zeiss Observer. D1m Optical Microscope



Purpose

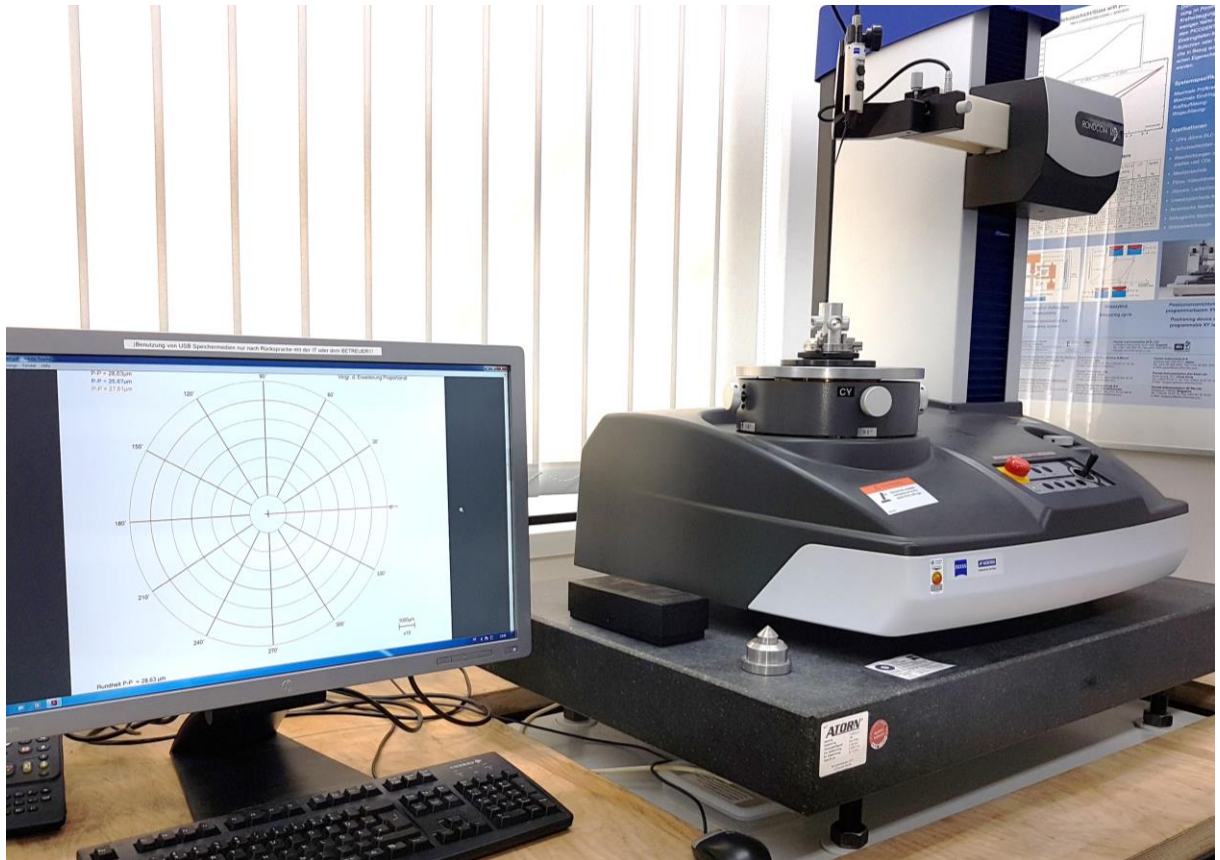
Optical analysis of metallographic specimens. Manual stage with automatic objective lens recognition. Brightfield and simple polarization observations available.

Specifications

- General optical microscopy
- Up to 1000x magnification
- Zeiss Application software AxioVision embedded with measuring capability
- Manual lens selection and table movement
- Camera resolution 1.4 MP

Metrology capability

Zeiss Universal Form Tester RONDCOM NEX



Purpose

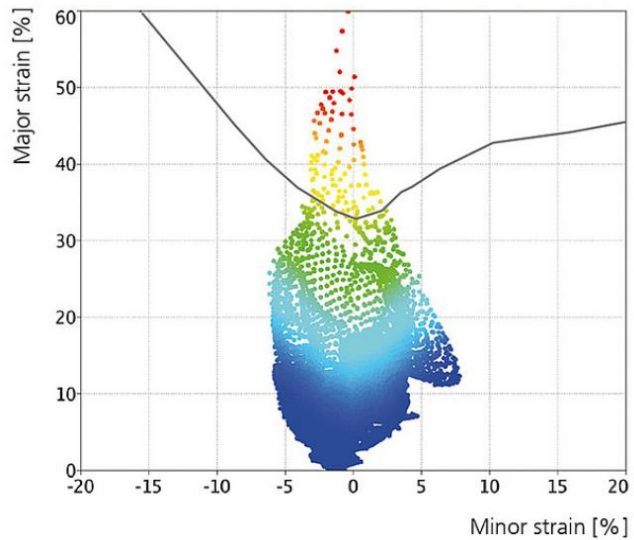
Universal form tester RONDCOM NEX for the measurement and evaluation of roundness, cylindricity, squareness, parallelism, straightness, flatness, coaxiality, concentricity and thickness deviation on rotationally symmetrical components.

Specifications

- High-precision, wear-free, air-bearing rotary platform.
- Roundness deviation $0,01 + 0,00016$ (Filter 50 W/U)
- Measurable diameter: 300 mm
- Maximum workpiece diameter: 580 mm
- Line straightness z-axis: $0,1 \mu\text{m}$ (100 mm)
- Maximum workpiece weight: 30 kg
- Measuring range z-axis: 500 mm

Metrology capability

GOM Argus



Purpose

High-resolution images used to capture the molded part are evaluated by the ARGUS software. From the 3D coordinates of the object points, the actual results of the shape changes and the sheet thickness are calculated, taking into account the component geometry and according to the rules of the plasticity theory. This makes the ARGUS software suitable for a wide range of tasks in the field of sheet metal forming, such as detection of critical deformation areas, solving complex forming problems, optimization of forming processes, evaluation of tools, and adjustment and optimization of numerical simulations.

Specifications

- Comfortable interface for different camera types
- Automatic multiple image capture in difficult contrast conditions
- Automatic calculation of 3D surface coordinates and local deformation of the surface with strains
- Calculation of thickness reduction and deformation
- Calculation of yield stress with known flow curve

Metrology capability

Nanofocus μ Surf mobile

Purpose

The Nanofocus μ Surf is a mobile device used for optical surface characterisation, based on the confocal technology.

Specifications

- Optical 3-dimensional surface digitisation based on focus variation within nanometers combined with confocal technology
- Surface profile form, roughness measurement and layer thickness
- Driven X, Y, Z axes
- Automatic stitching of multiple measuring fields
- 10x and 50x objective

Metrology capability

Fischer Fischerscope Film Thickness Tester



Purpose

The Fischer Fischerscope MMS PC2 is a stationary analysis tool which can be used in combination with multiple measuring sensors for specific film thickness measurements. The Fischer Betascope sensor is used for thickness testing of oil films or polymer layers.

Specifications

- Thickness testing of nanolayers and gold layers
- Thickness testing of oil and water layers

Metrology capability

Thermal Imaging Camera



Purpose

This Trotec IC 0120 LV is a thermal imaging camera used for high temperature measurement of tools and dies.

Specifications

- Temperature range: -20 to +600 °C
- Resolution: 384 x 288 pxl
- Wavelength: 7.5 – 14 μm

Furnace and handling capabilities

Nabertherm Furnace LF 15/14-S



Purpose

The Nabertherm LF 15/14-S is used for heat treatment applications. A five-side heating guarantees homogenous heat in the chamber. High-quality fibre-isolations and built cornerstones reducing cooling times as well as heating times. A programmed cooling curve can be realized by a controlled exhaust air flap and a fresh air electric fan.

Specifications

- Heating chamber: 250 x 250 x 250 mm
- Power: 8 kW
- Tmax: 1400 °C
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive
- Additionally a gas feed box can be inserted

Furnace and handling capabilities

Nabertherm Furnace N500/85HA



Purpose

The nabertherm N500/85HA is used for heat treatment applications. It features a large 500 litres heating chamber with a maximum temperature of 850 °C and a fan cooling system.

Specifications

- Heating chamber: 750 x 1000 x 750 mm (width x depth x height)
- Power: 30 kW
- Tmax: 850 °C
- Heating time until Tmax: 180 min
- Fan cooling time (Tmax to 150 °C): 210 min
- NTLog Basic for Nabertherm controller: recording of process data with USB-flash drive

Furnace and handling capabilities

Induction Heating System KUKA



Purpose

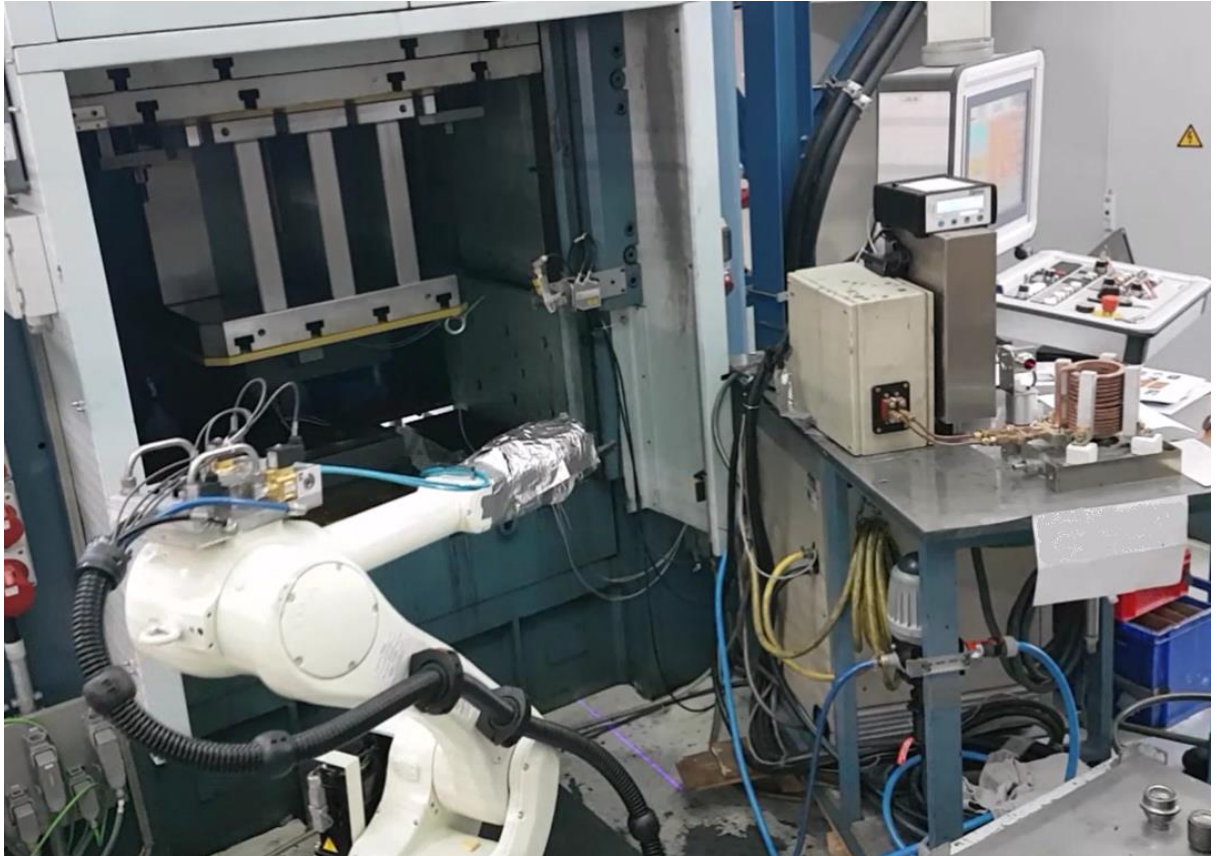
The KUKA induction heating system allows a controlled heat penetrating depth of the metallic specimen by adjusting the inverter frequency in a range between 1000 and 4000 Hz. The heating power is regulated by pulse width modulation.

Specifications

- Power: 60kW
- Heating frequency: 1.000 – 4.000 Hz
- Pulse width modulation for power regulation

Furnace and handling capabilities

Kawasaki RS010L Robot



Purpose

Automation, accuracy, repeatability, security and control.

Specifications

- 6 axes articulated robot.
- Repeatability: ± 0.05 mm (at the tool mounting surface)
- Max. payload: 10 kg
- Max. speed: 13100 mm/s (at the tool mounting surface)
- Working range: 1925 mm front, 1625 mm back
- Mass 230 kg (without base plate) + 40 kg controller unit

General machine tool capability

Kekeisen Bed Milling Machine



Purpose

The universal bed milling machine Kekeisen UBF 2500 is used for milling large-scale deep drawing tools as well as for general toolmaking processes.

Specifications

- Max. spindle speed: 2000 1/min
- Max. spindle rating: 30 kW
- X-axis travel: 2500 mm
- Y-axis travel: 1300 mm
- Z-axis travel: 1200 mm
- Spindle cone SK50
- Control: Siemens 840
- Max. workpiece weight: 7000 kg
- Table size: 2700 mm x 840 mm

General machine tool capability

DMG Universal Milling Machine



Purpose

The DMG DMU50 is a universal 3+2 axis milling machine used for toolmaking purposes.

Specifications

- Max. spindle speed: 10000 1/min
- Max. spindle rating: 12 kW
- X-axis travel: 500 mm
- Y-axis travel: 450 mm
- Z-axis travel: 400 mm
- Spindle cone SK40
- Control: Heidenhain iTNC 530
- Max. workpiece weight: 200 kg
- Table size: 630 mm x 500 mm

General machine tool capability

Spinner CNC Turning Center



Purpose

The SPINNER TC600 turning center is used for general toolmaking purposes. It provides a 16 station VDI 30 turret with live tooling and y-Axis as well as a sub spindle.

Specifications

- Max. spindle rating: 18 kW (main), 12 kW (sub)
- Max. spindle speed: 4000 1/min, 6000 1/min (sub)
- Max. cutting diameter: 400 mm
- X-axis travel: 275 mm
- Y-axis travel: 90 mm
- Z-axis travel: 700 mm
- Turret: 16 stations, VDI 30, live tooling 5000 1/min
- Control: Siemens 840D Solution Line

General machine tool capability

Trumpf TruShear 3103 Hydraulic Shear



Purpose

The Trumpf TruShear 3103 is a hydraulic shear which offers precision cut sheet material and is capable of cutting up to 3 m wide sheet and up to 10 mm thick mild steels.

Specifications

- Shearing width: 3 m
- Shearing thickness: 10 mm (mild steels)
- Automatic sheet stop: 10 – 1000 mm

General machine tool capability

Wire Drawing Machine



Purpose

Test drawing machine for the investigation of wire and pipe drawing processes.

Specifications

- Wire- and pipe drawing tests
- Ultrasonic assisted wire- and pipe drawing
- Drawing velocity: 0,6 – 16,2 m/min
- Maximum drawing force: 120 kN
- Max. stroke: 1200 mm
- Inductive displacement sensor
- Piezoelectric force sensor

General machine tool capability

Felss HE-16V Rotatory Swaging Machine



Purpose

Rotary swaging machine in small size for the precise reduction of the outer diameter of tubes. By using a mandrel, also the inner tube diameter can be adjusted.

Specifications

- Radial forging for diameter reduction of tubes
- Rotatory velocity of the swaging shaft up to 342 rpm
- Hammering frequency: 40 Hz
- Maximum force per segment with normal wear: 45 kN
- Maximum force per segment with high wear: 65 kN
- Maximum outer tube diameter: 16 mm
- Manual workpiece feeder

General machine tool capability

Teschauer Laser Labeling Machine



Purpose

The Teschauer TL 1216 is used for laser labeling and features 16 W disc laser power.

Specifications

- Disc laser source
- 16 W laser power
- Wavelength: 1064 nm
- Air cooling for laser
- Labeling area: 80 mm x 80 mm

General machine tool capability

Abrasive Blast Cabin MHG SMG 50



Purpose

Abrasive blast cabin for various applications such as surface treatment prior to lubricant application, cleaning, deburring, or finishing.

Specifications

- Dust proof vacuum cabin with blasting material recovery
- Working space dimensions:
1100 x 660 x 816 mm (width x depth x height)
- Standard blasting material:
glass beads, 100 – 200 µm diameter (others available)
- Manual operation by foot pedal and blasting gun for large parts and locally blasting
- Automatic operation by rotary drum and programmable blasting duration for small parts
- Two side doors, dust proof closing, double-walled, sound-absorbing foamed, lockable, with electrical switch-off protection