Turning into Solutions.

mesa parts

Turning Parts for Hydrogen Applications

October 2020

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2. Case Study Hydrogen Parts
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   - Materials for Hydrogen Applications
   - Model for Case Study
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3. Manufacturing Process and Gas Tightness
4. Summary

Mesa Parts GmbH

Mesa Parts is a leading engineering and production partner for complex turned parts and subassemblies based on turned parts for internationally operating customers.

- Established in 1896 – family-owned business in the 4th generation in Lenzkirch, Black Forest
- Production sites in Lenzkirch (DE), Nachod (CZ) and Lerma de Villada (MX)
- All plants IATF 16949 and ISO 9001 certified
- Metal cutting, grinding and fine machining – testing – calibration – assembly – packing – custom machinery
- Production output: approximately 1 million parts per day

Experienced in production of high precision parts for combustion vehicles

FCEV is future focus market segment for Mesa Parts

Case Study Hydrogen Parts

Objective: To improve the high production knowledge with respect to surface area requirements for hydrogen applications

Steps of case study:

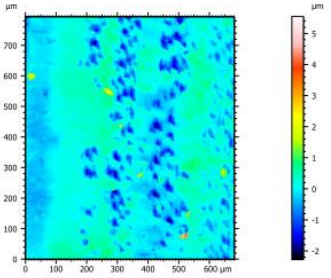
1. Design of a part with typical functional surfaces (sealing, guidance, bypass)
2. Selection of materials that are widely used in hydrogen applications
3. Production of the parts with different processes
4. Measurement of different surface parameters to assess the outcome

Increasing manufacturing Know-how for special needs of hydrogen application with focus on surface parameters

Functional Requirements and Surface Parameters

From inquiries for hydrogen applications Mesa Parts knows that requirements for surfaces are high. We understand that there is not just one surface parameter to specify the surface and secure the needed function:

- For different functional requirements different surface parameters are relevant
- Sealing surfaces need to be defined by other parameters than sliding surfaces
- Sealing surfaces for static sealing have different necessities than for dynamic seals
- Guiding surfaces request other finishing than sealing surfaces



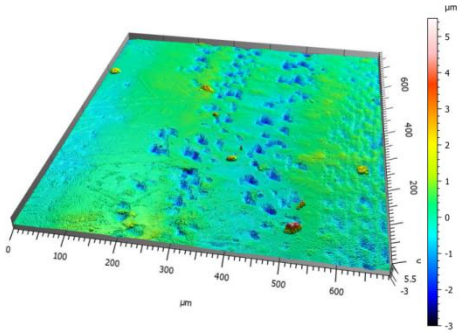
Mesa Parts understands the needs for different surface parameters

Best surface parameter for required function has to be determined together with customer

Functional Requirements and Surface Parameters

Measuring:

- Different measurement methods available in house
- Control of surface parameter in serial production



Mahr

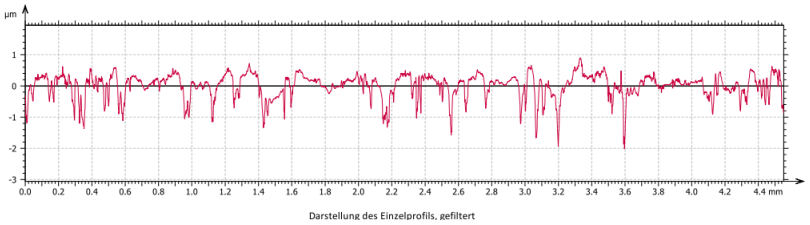
MarSurf M 400

MESA PARTS
LUDWIG-KEGEL STR.15
D 79853 LENZKIRCH
Tel. +49 7653 683-0

Datum	16.08.2016
Uhrzeit	08:43
T0 BFW-250	250 1
Lt	1.750 mm
Ls GS	aus
Lc GS	0.250 mm
Ra	0.803 µm
Rz	4.394 µm
Rmax	5.187 µm
Rp	2.329 µm
Rmr(-0.30,5.0)	9.7 %
Pmr(-0.30,5.0)	5.9 %
Pt	10.59 µm

R Profil	POS
Lc GS	0.250 mm
HOR	0.250 mm
VER	2.50 µm

Rauheitskennwerte - Rauheit1: P; R[LC GS 0.8 mm]		
Ra	0,0273 µm	0,0000
Rz	0,1722 µm	0,0000
Rmax	0,1978 µm	0,0000
Rp	0,0973 µm	0,0000



ISO 4287				
Amplituden-Parameter - Rauheitsprofil				
Ra	0.293	µm	Gauß-Filter, 0.8 mm	Arithmetische Durchschnittsabweichung des Rauheitsprofiles.
Rq	0.393	µm	Gauß-Filter, 0.8 mm	Durchschnittliche quadratische Abweichung (RMS) vom Rauheitsprofil.
Rz	2.17	µm	Gauß-Filter, 0.8 mm	Maximale Höhe des Rauheitsprofiles.
Rp	0.667	µm	Gauß-Filter, 0.8 mm	Maximale Spitzenhöhe des Rauheitsprofiles.
Rv	1.50	µm	Gauß-Filter, 0.8 mm	Maximale Muldentiefe des Rauheitsprofiles.

State of the art measuring technology to ensure manufacturing operations

ISO/TS 16949 and ISO 14001 certification

Materials for Hydrogen Applications

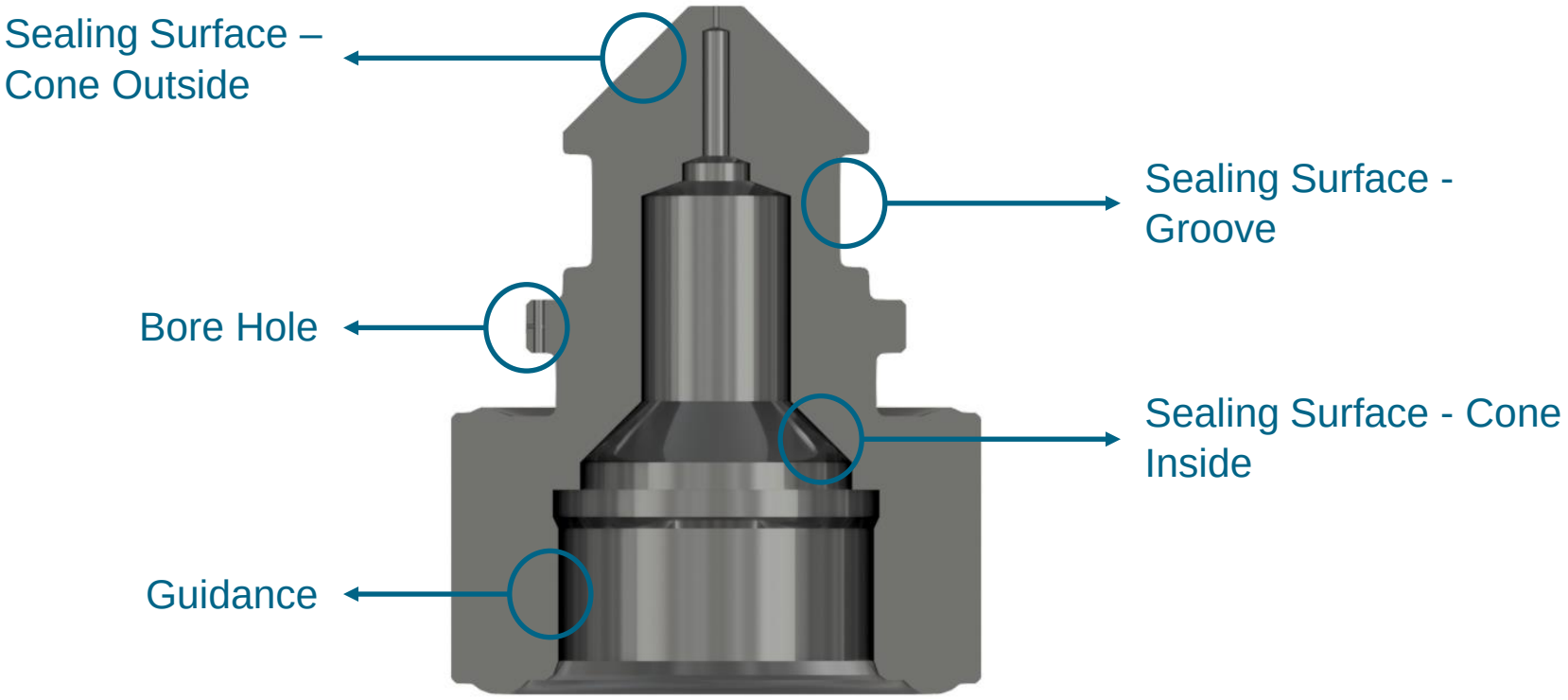
- Different functional requirements result in different materials
- Different materials require different manufacturing parameters

- Hydrogen proved materials used in this case study:
  - Austenite: 1.4435 (S 31603), 1.4571 (S 31635)
  - Ferrite: 1.4016 (S 43000)
  - Aluminum: 3.3211 (A 96061)

Our core competence is serial production of parts with materials difficult to process

Requirements for hydrogen components fit very well to our competencies

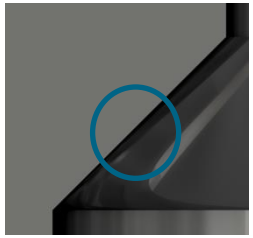
Model for Case Study

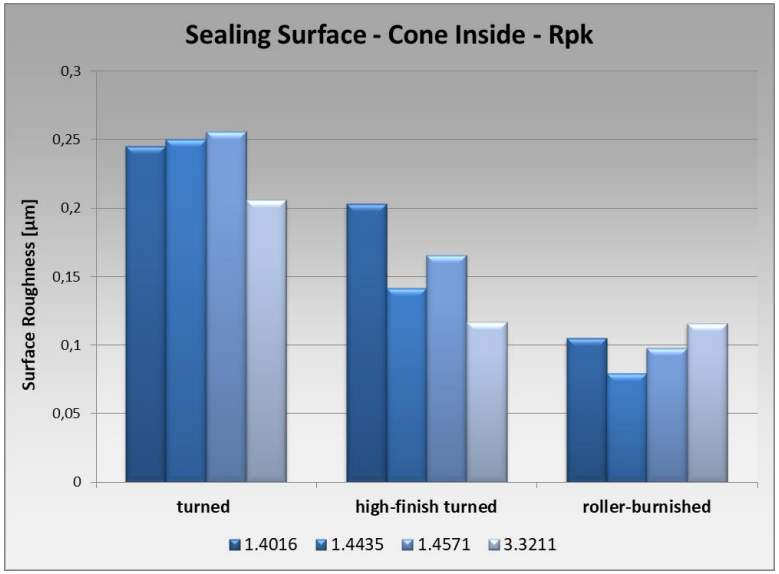


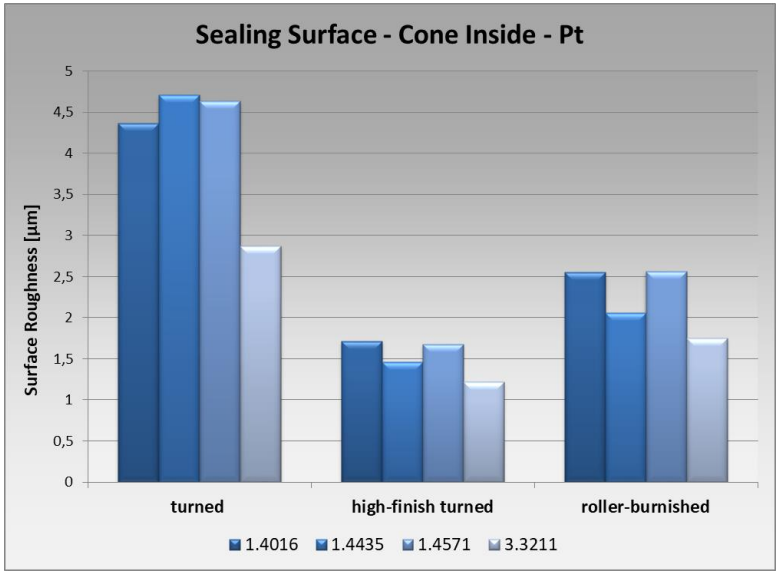
Part for case study with different functional features and surfaces

Exemplary Results of Case Study

Sealing Surface - Cone Inside





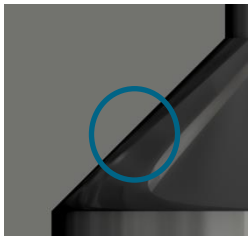


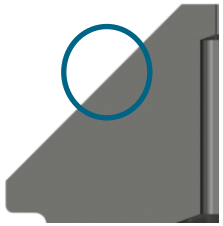
Roller-burnishing results in lower Rpk value

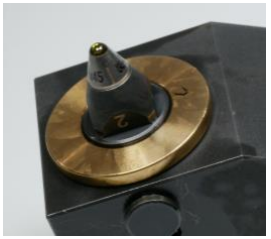
For lower Pt high-finish turning is the process to choose

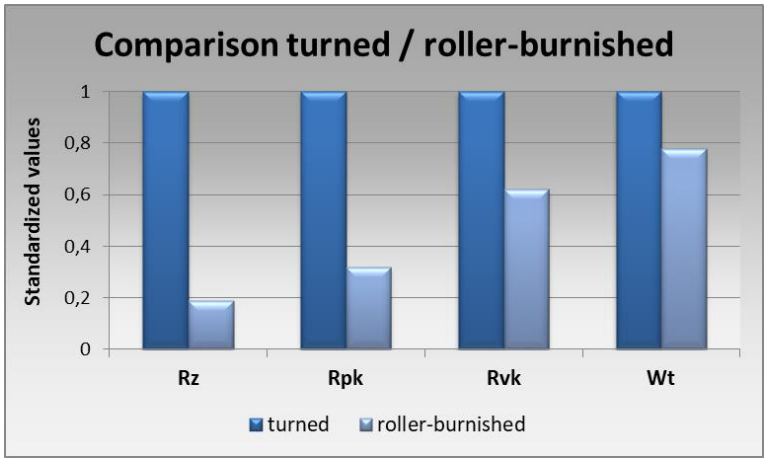
Exemplary Results of Case Study

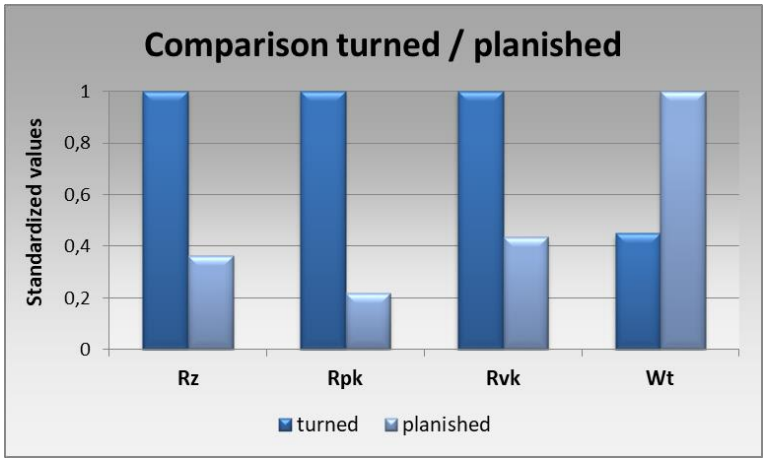
Sealing Surface – Cone Surfaces







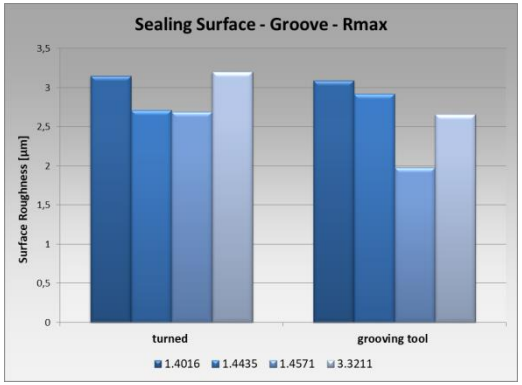


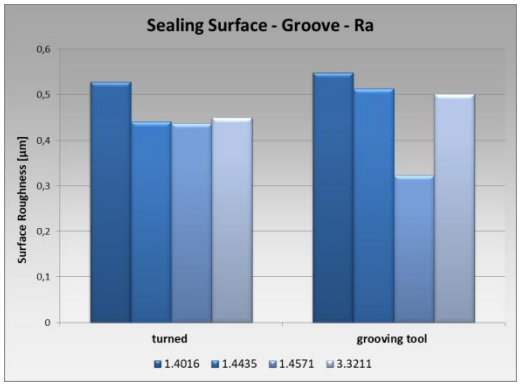


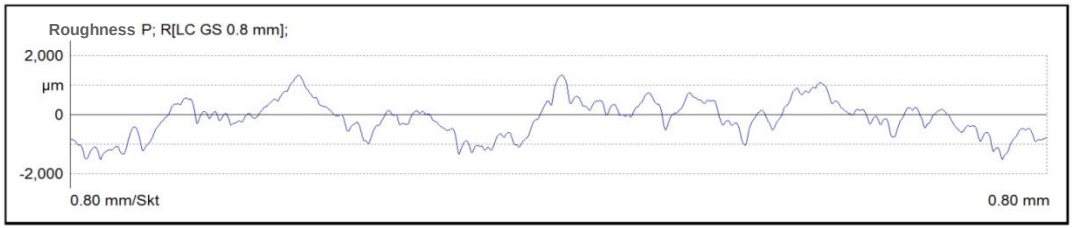
- **Improved surface by roller-burnishing and planishing shown by Rz and Rpk**
- **Planishing shows higher improvements for Rvk**
- **Planishing has negative impact on Wt**

Exemplary Results of Case Study

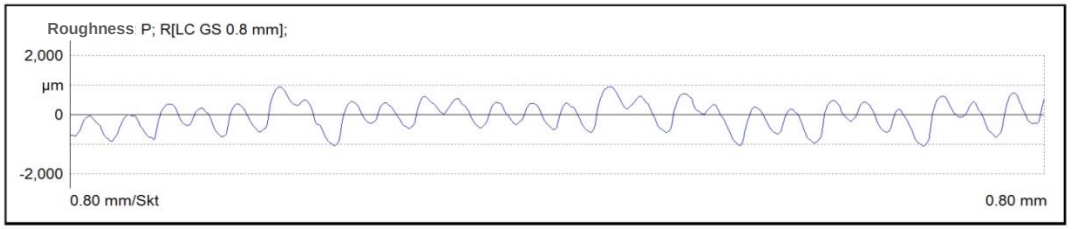
Sealing Surface – Groove







Grooving Tool

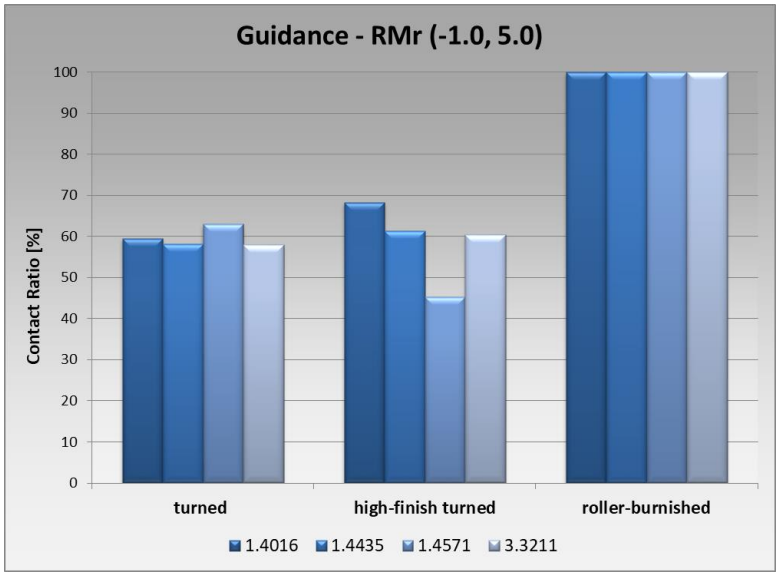


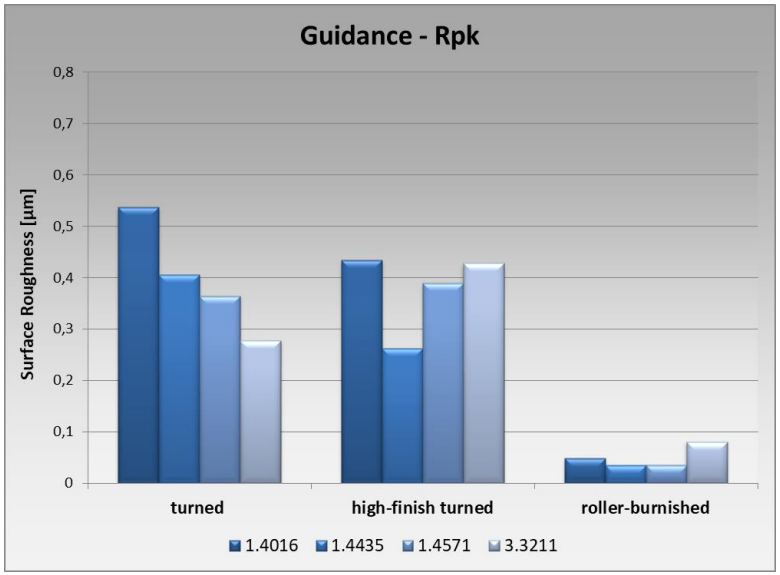
Turned

- **Similar Rmax and Ra for both manufacturing processes**
- **Turning leads to a smoother surface, but helix bears the risk of forming a leakage path**

Exemplary Results of Case Study

Guidance

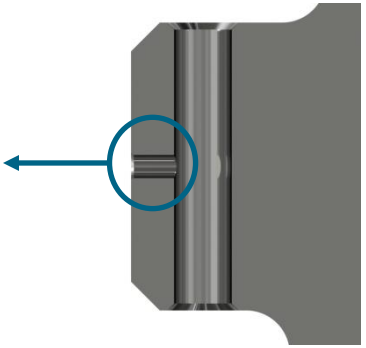




- **Roller-burnishing improves the contact ratio RMr**
- **Roller-burnishing leads to much lower Rpk values**

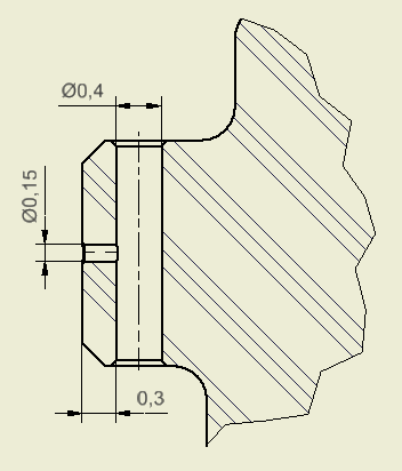
Exemplary Results of Case Study

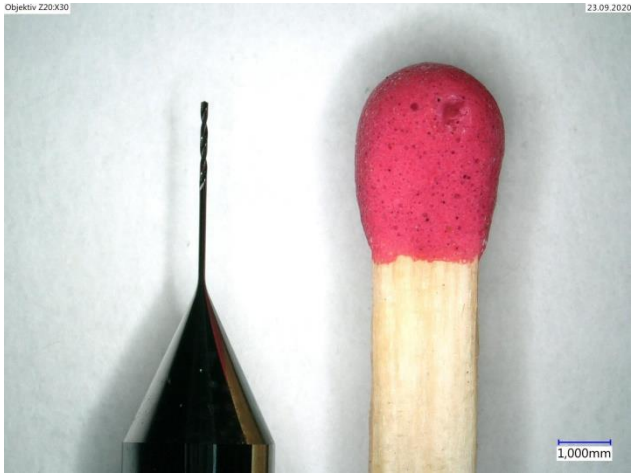
Bore Hole



Bore Hole:

- Possible even in materials used in hydrogen applications
- Ø 0,15 mm bore already industrialized in serial product



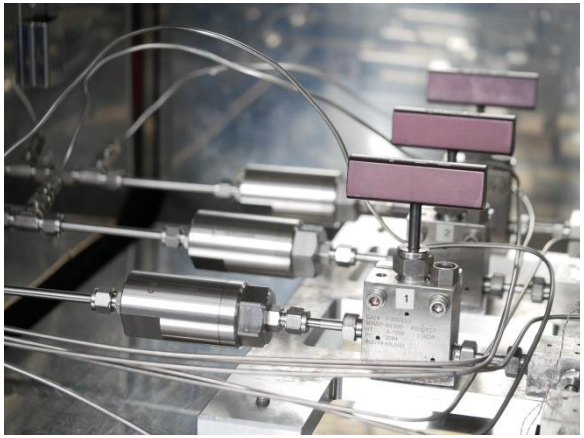


Small diameter bores are often realized for our customers

Manufacturing Process and Gas Tightness

Objective: For the design feature inner cone from the case study a housing was designed to determine the influence of different manufacturing parameters on the leakage rate

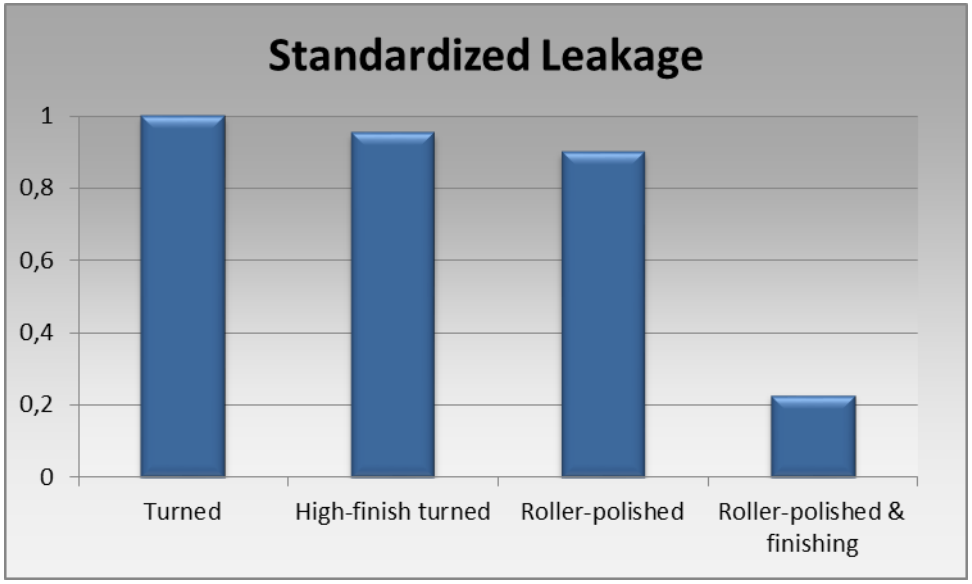
- Model manufactured with different processes
- Different materials used
- Seal made of PEEK
- Measurements with 100% Helium at 20 °C and 7 bara



Will different manufacturing parameters lead to different leakage rates?

Manufacturing Process and Gas Tightness

Exemplary results for 1.4016:



- **Same system produced with different processes leads to different leakage rates**
- **Roller-burnished parts show 10% less leakage compared to turned parts**
- **Further improvement of leakage rate possible with finishing step**

Summary

Mesa Parts is your partner for the production of demanding hydrogen components

- **All hydrogen relevant materials can be manufactured**
- **All machining processes proved for large scale series**
- **In-house assembly and testing established**
- **Different requirements need different surfaces: Mesa Parts will identify the best suited surface parameter and manufacturing process with you during prototype phase**

We make the high-precision parts for your hydrogen business

Mesa Parts – Turning the hydrogen world into Solutions

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