Technologies and Nanotechnologies of Magnetic-Abrasive Machining of Surfaces

Speaker:

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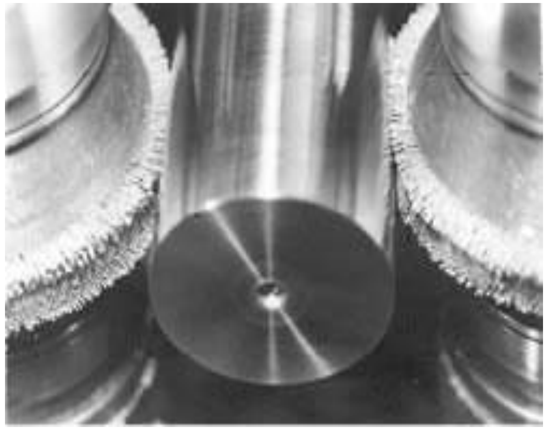
Minsk 2020

Method

- The magnetic field transforms the ferroabrasive powder into a kind of an "elastic brush" and polishes the surface



- Pulsing magnetic field improves the structure of the preface layer of the material

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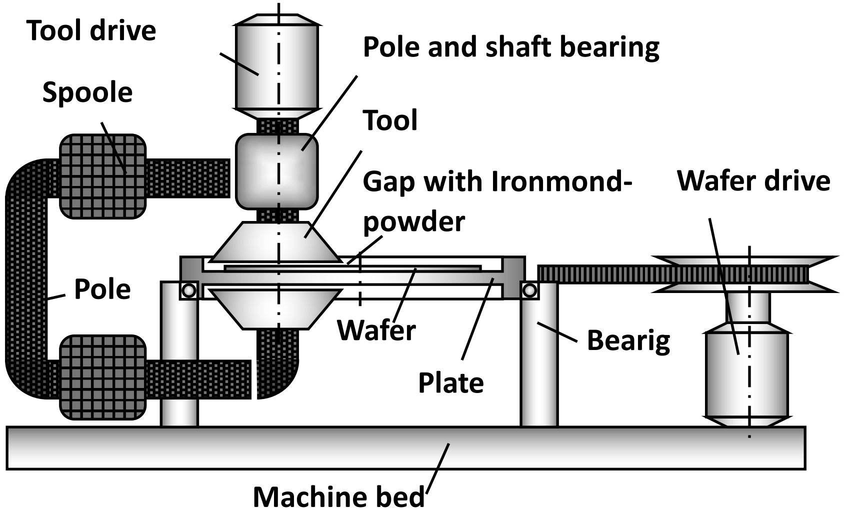
Application

- Formation of surface nanorelief
- Polishing surfaces before coating
- Cleansing surfaces before welding
- Polishing surfaces to increase resistance to corrosion, wear and mechanical destruction
- Surface modification under physical-chemical processes (diffusion, adhesion, etc.)

Experimental model for polishing plate surfaces



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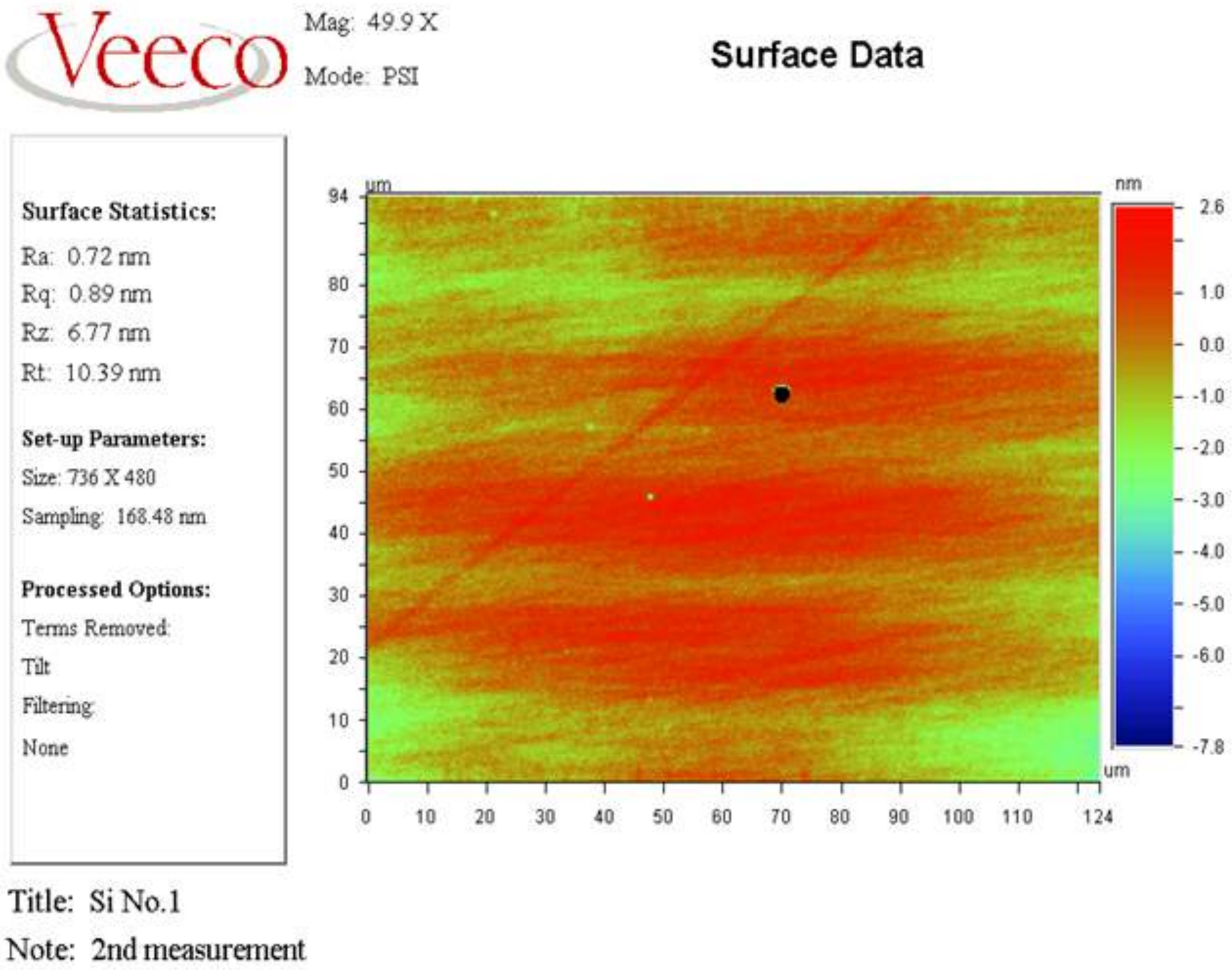
Polishing of electronics: Si-wafers

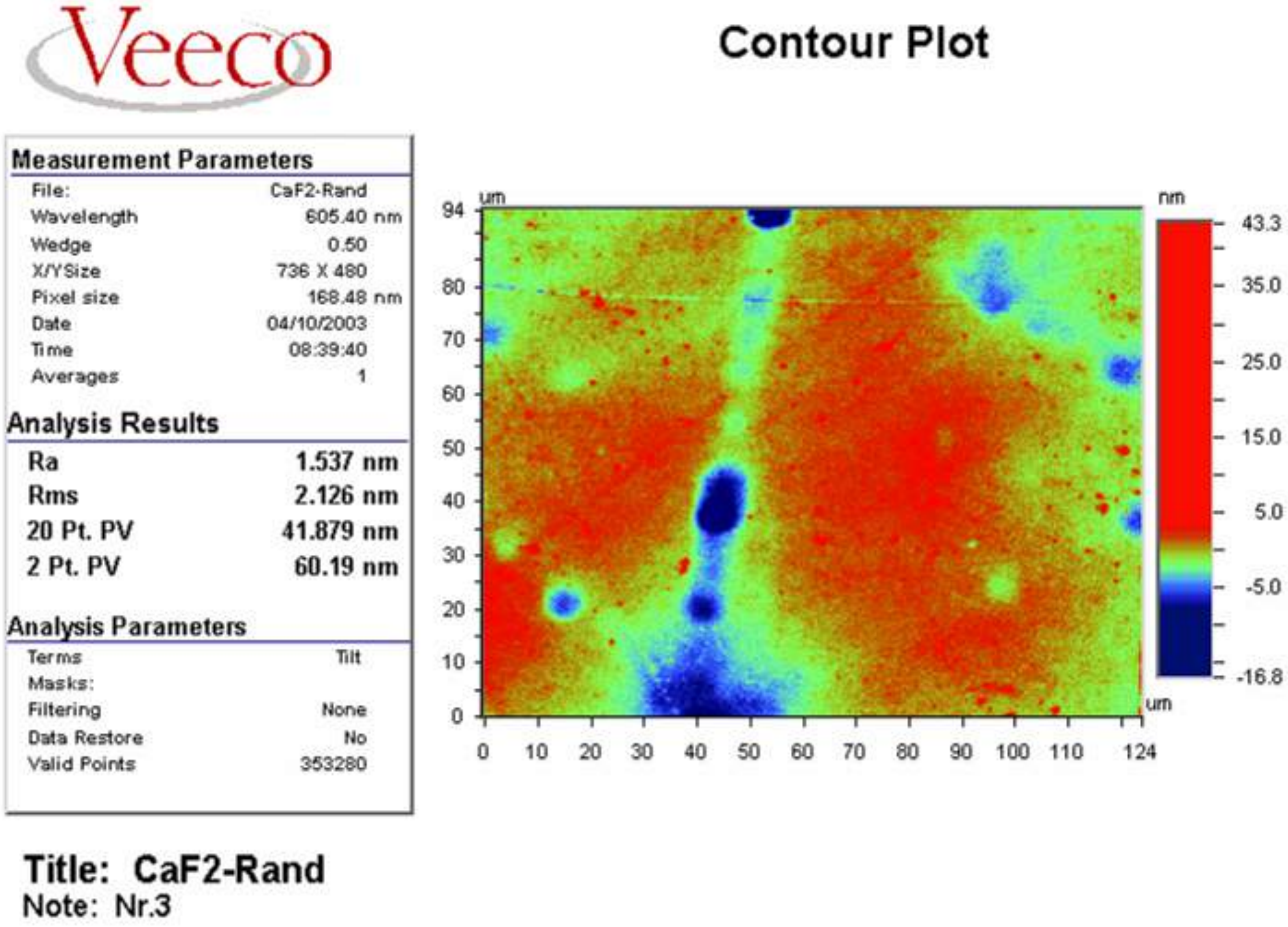
Ra = 0.72 nm

TTV = 2.9 μm



Polishing laser crystals (CaF_2 and other)

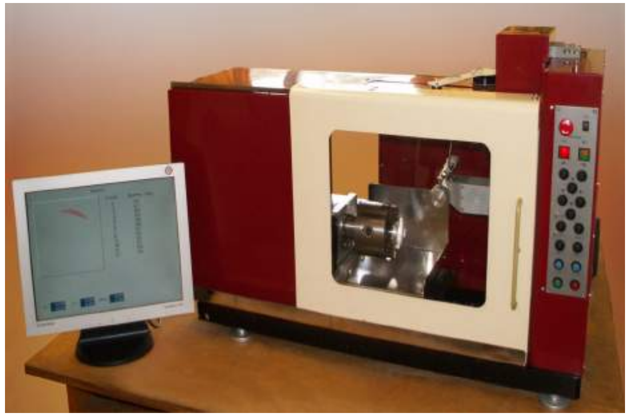
Ra = 1.537 nm



Superfine polishing

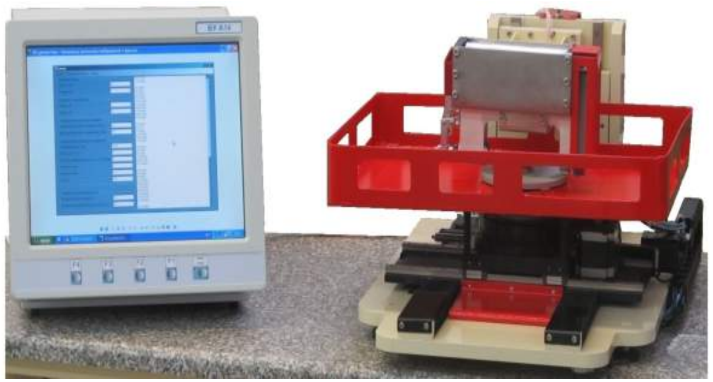
3905

Valid layout



A09

Experimental sample



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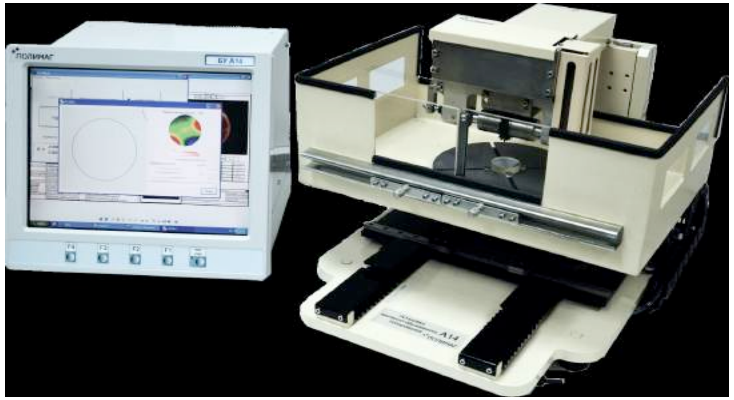
Experimental sample



A17

Industrial model

Laser induced damage threshold

LIDARIS
LIDT Service

POLIMAG – SO1176

COMPARISON OF LIDT VALUES

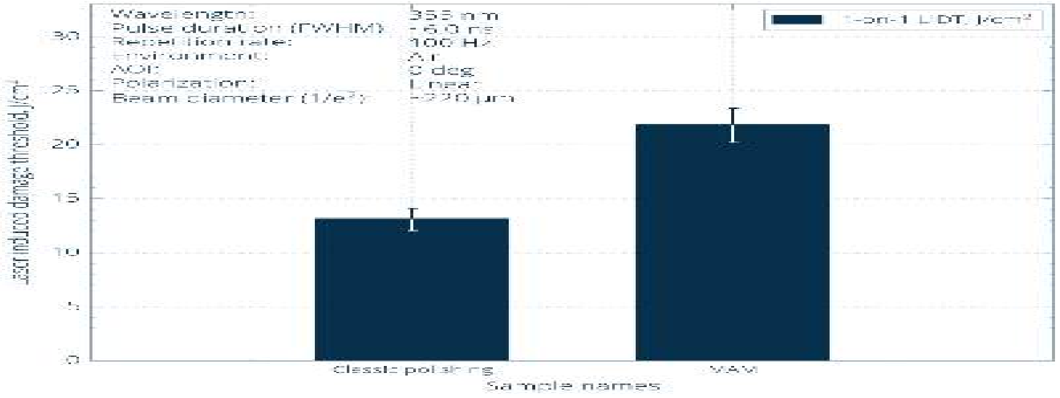


Figure 1: Comparison of SO1176 measurements.

Table 1: SO1176 data spreadsheet

Sample	Threshold (1-on-1)	Error lower	Error upper
MAM	21,80	1,58	1,58
Classic polishing	13,13	1,07	0,96

Features of superfine polishing

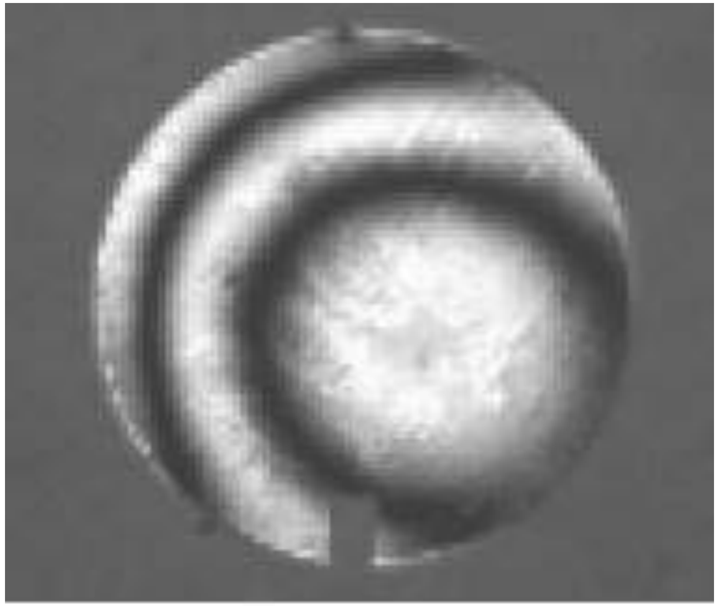
Application: surfaces of high-precision details of optics, lasers, micro- and nanoelectronics, etc.

Benefits:

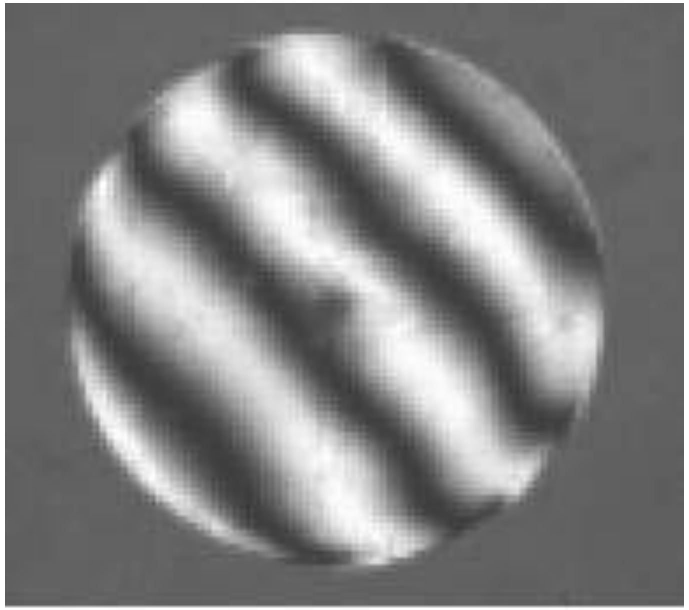
- Very high quality
  - Roughness, Ra:
    - before: 8 – 10 nm
    - after: 0.2 – 0.8 nm
  - minimum defects in the structure of the surface layer
- Performance is 4-10 times higher than that of other technologies
- Cost is 3 - 5 times lower than cost of other technologies
- Environmental friendliness

Optical glass polishing

Interferograms of optical glass before and after MAM



Before MAM: **PV = 158 nm**
Ra = 20 nm



After MAM: **PV = 30 nm**
Ra = 1.4 nm

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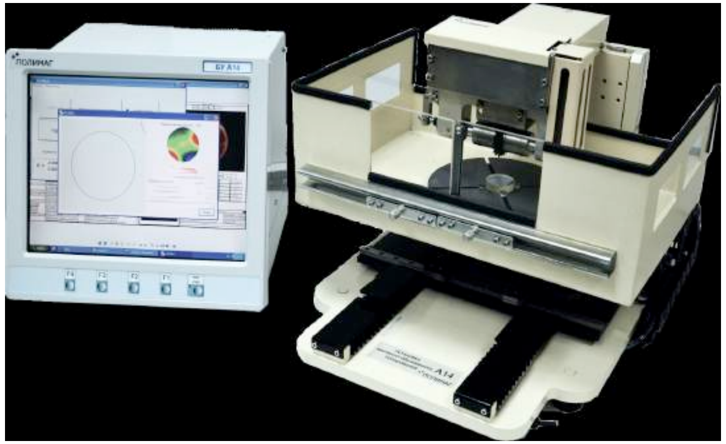
Magnetic-Abrasive Polishing of plain, spherical and aspherical surfaces

Model A17



	Before MAM		After MAM
Sa	**0.27 nm**	**Sa**	**0.14 nm**
Sq	0.369 nm	Sq	0.189 nm
Sp	4.58 nm	Sp	1.13 nm
Sv	3.66 nm	Sv	0.735 nm

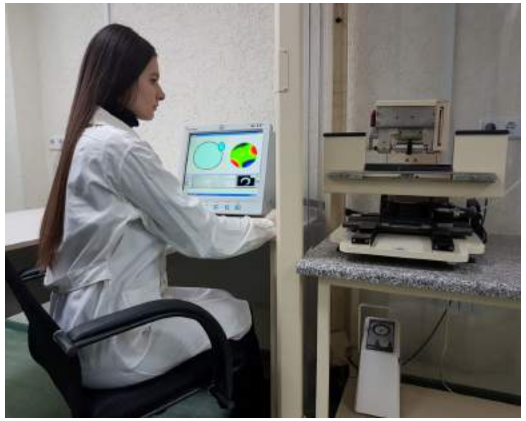
ISO 25178

Technical characteristics

Piece diameter	10 - 200 mm
Ra of the polished surface	0.2 – 0,8 nm
Polishing time	2 - 15 min
Power consumption	1.5 kW
Size L×W×H	900 × 500 × 500 mm
Weight	80 kg

MAM potential

Model A17



Before MAM		After MAM	
Sa	**0.27 nm**	**Sa**	**0.14 nm**
Sq	0.369 nm	Sq	0.189 nm
Sp	4.58 nm	Sp	1.13 nm
Sv	3.66 nm	Sv	0.735 nm
Sz	8.24 nm	Sz	1.87 nm

ISO 25178

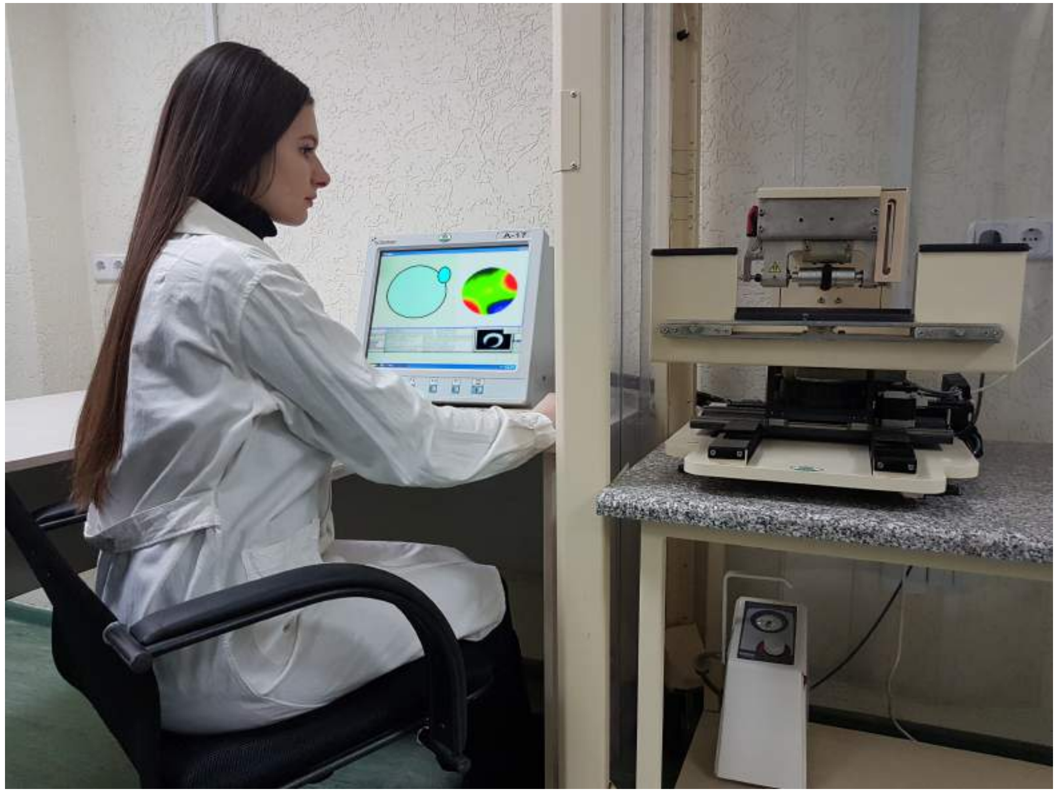
Analogs

MRF (Q22-XE)

Q-Flex 100

Model A17

A17 in the autonomous
clean zone



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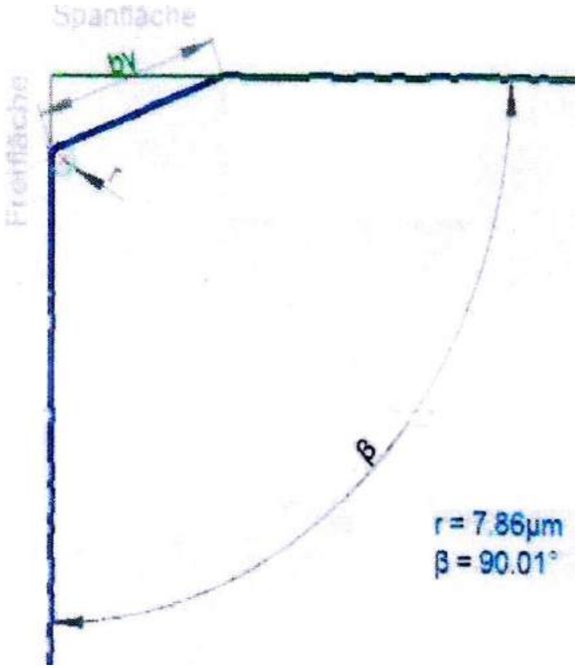
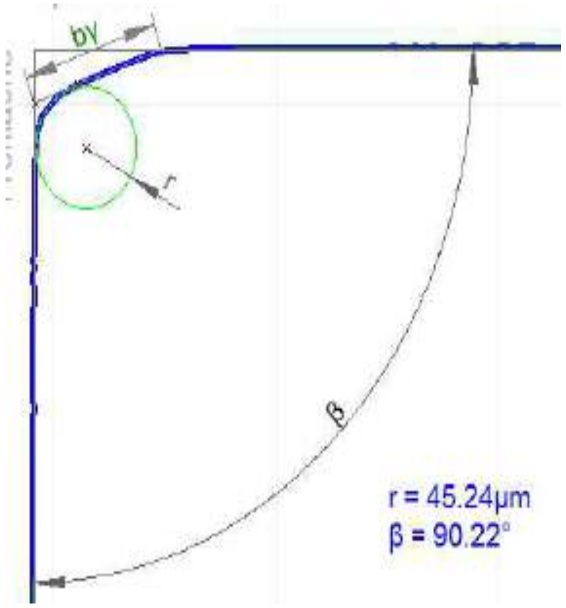
Polishing ceramics: plates for cutters and mills

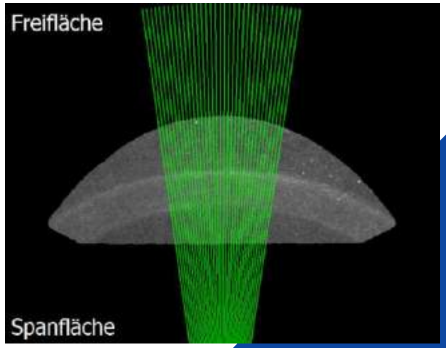
Before MAM	After MAM
r = 7.86 µm	r = 45.24 µm





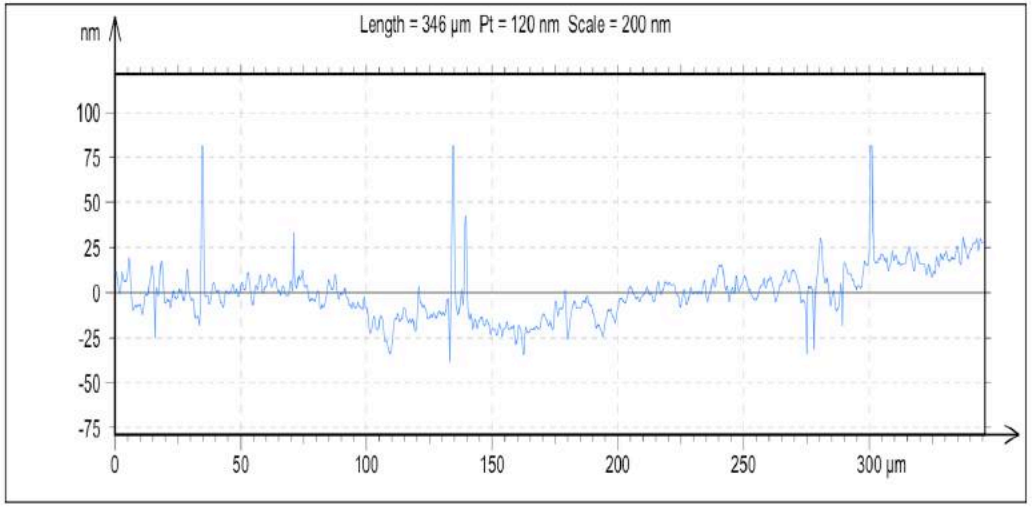
Vandurit GmbH, Germany

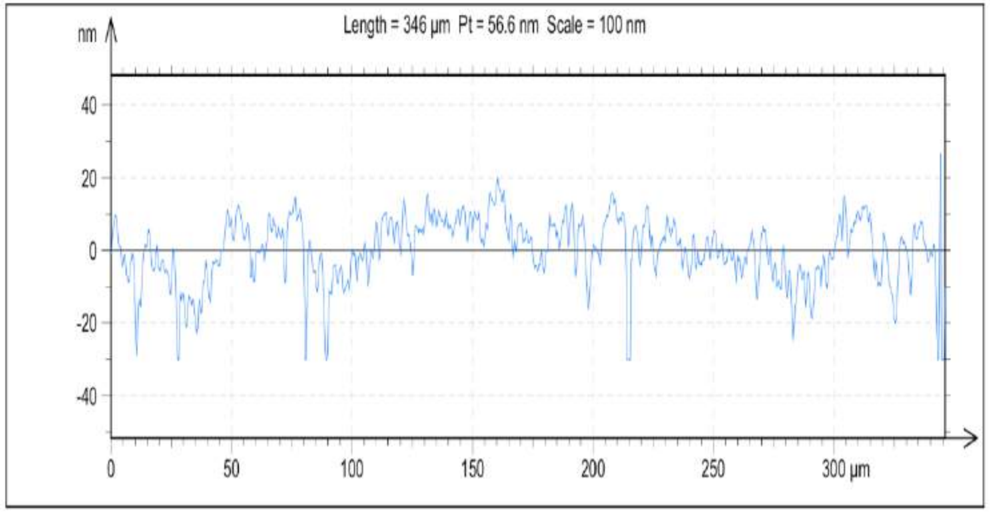
Materials	**Microhardness, GPa**
Diamond	100
Borazon	88
SiC	33
Al_2O_3	20
Si	12



MAP of artificial heart valve

Valve surface nanorelief:





Sash material (locking elements): pyrolytic carbon (sitall)

Before MAM		After MAM	
Ra	6.13 nm	Ra	3.91 nm
Rz	49.02 nm	Rz	24.39 nm
Sq	24.11 nm	Sq	9.41 nm

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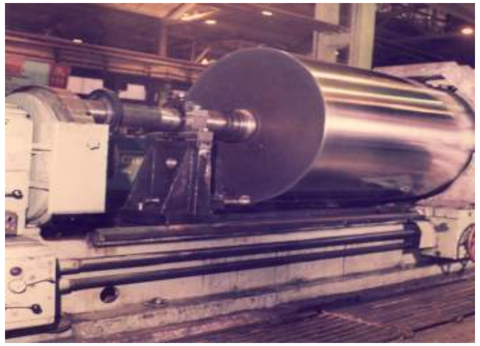
MAM equipment (polishing and cleansing) produced during between 1975 – 1995

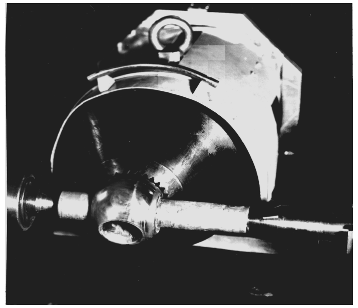
Cleansing edges before welding



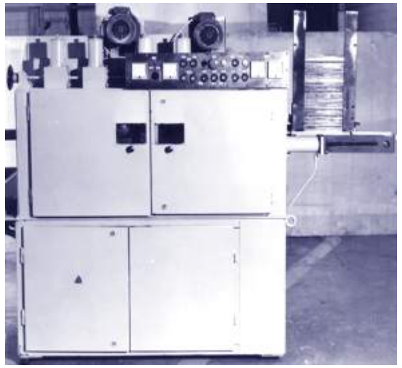
Polishing shafts

Polishing screws

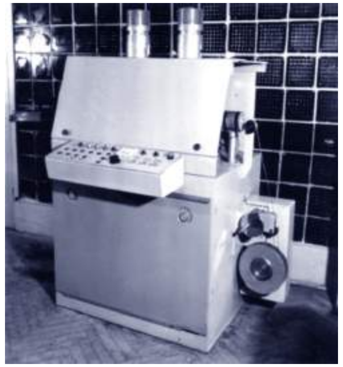
Cleansing plates and bands



Polishing spheres

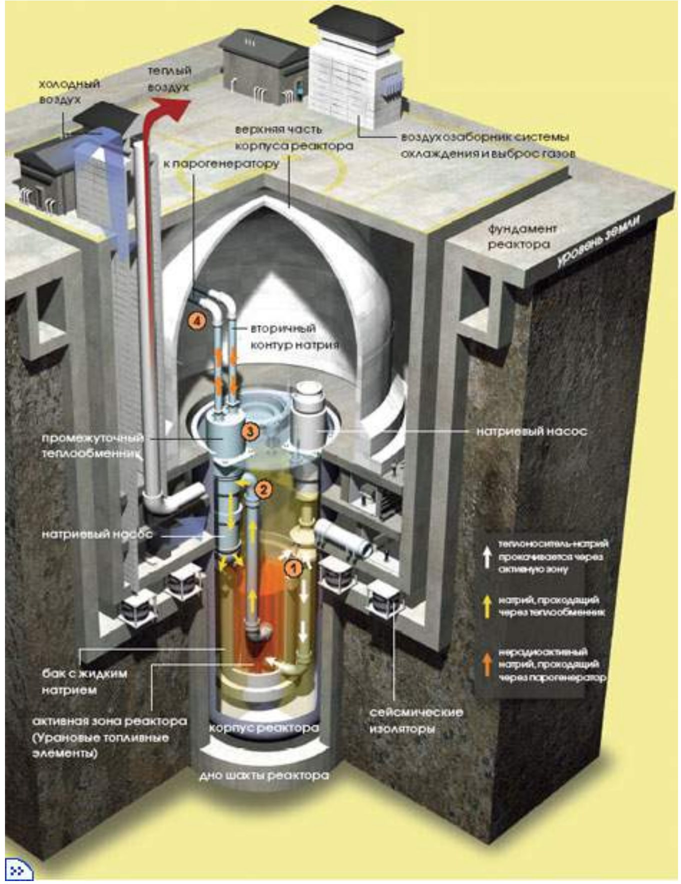


Polishing and cleansing pipes

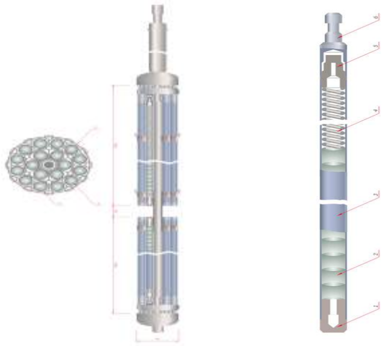


Cleansing wire

Magnetic abrasive polishing of fuel rods of nuclear reactors



Nuclear reactor scheme



Heat-releasing element (fuel rod)

Fuel cell assembly

T15 for polishing of pipes fuel rods

Conventional technologies (chemical etching, grinding and mechanical polishing) do not provide the required surface quality of pipes

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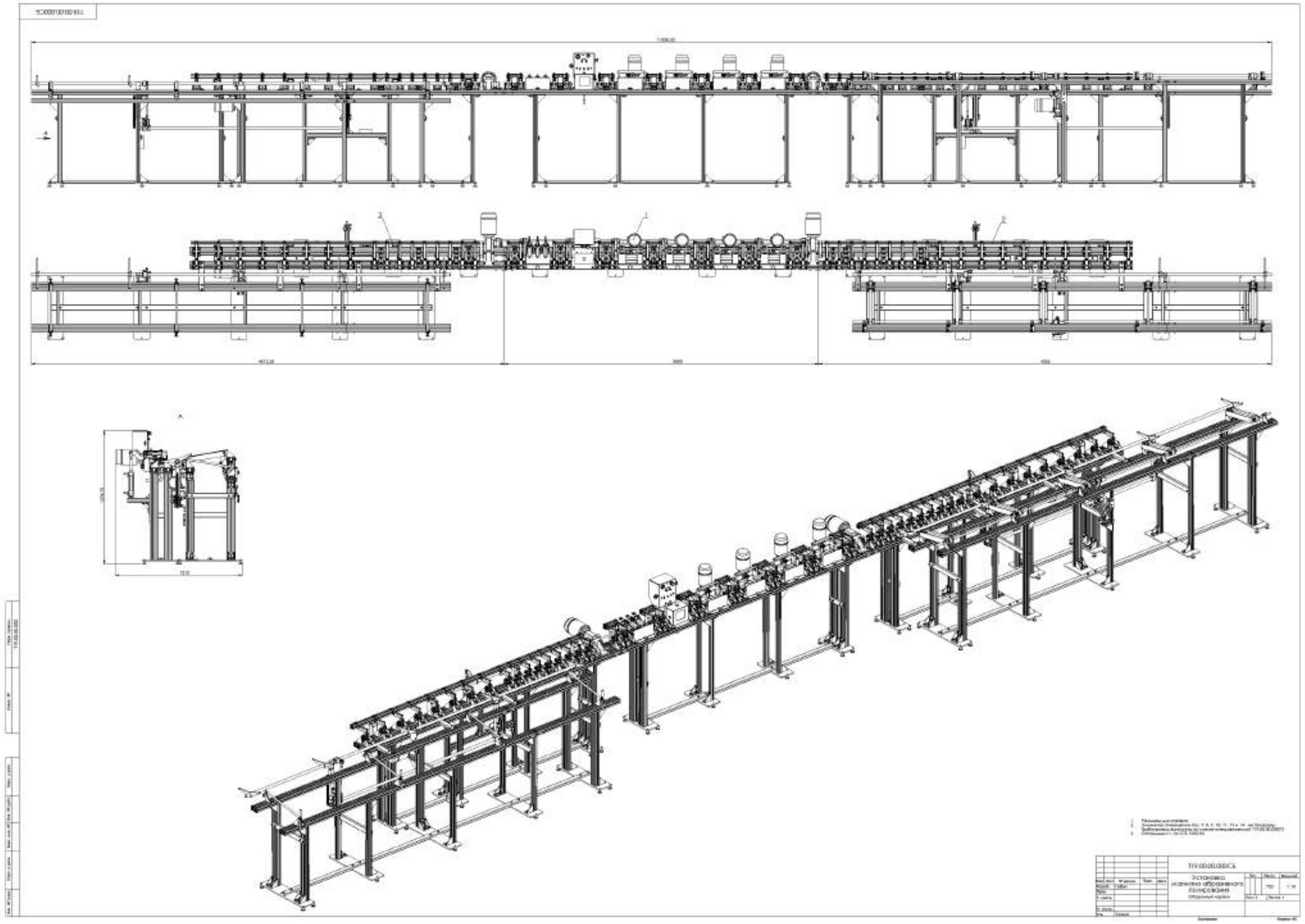
Automated model T19 for polishing of pipes fuel rods (under construction)



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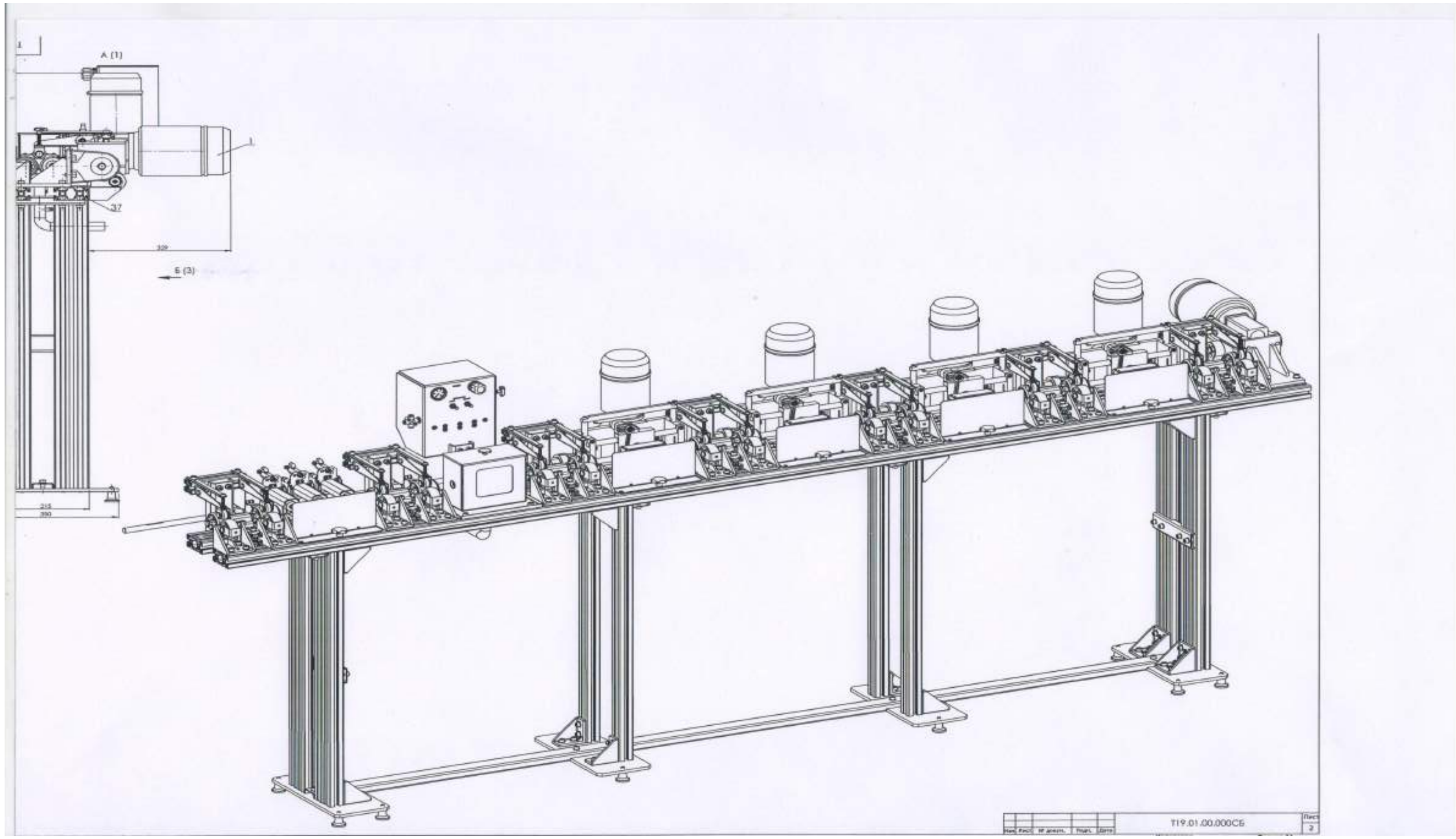
Automated model T19 in production



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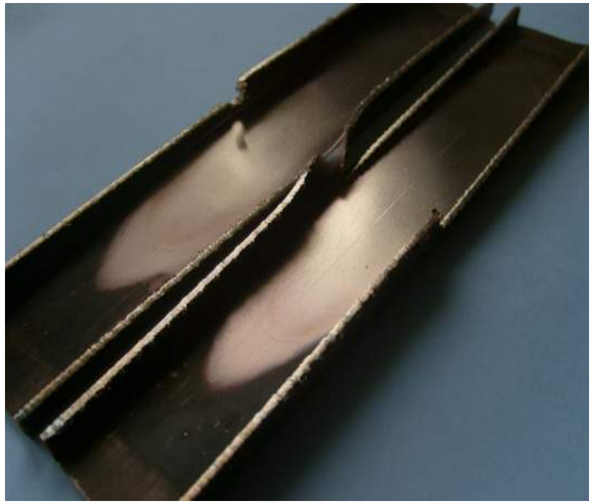
MAP of the inner surfaces of the waveguides

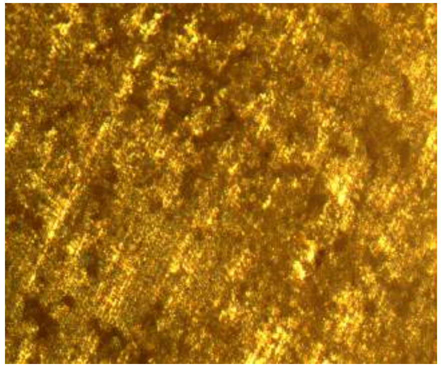


Waveguide material:
alloys Cu, Al and Si, steel, etc.

Before MAP	After MAP
Ra = **0.8** μm	Ra = **0.076** μm

MAP flat punch surface

Before MAP



100x

200 мкм

After MAP

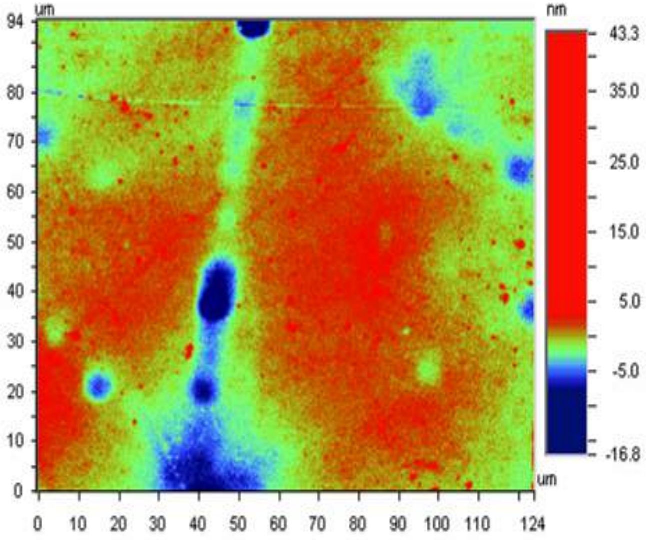
100x

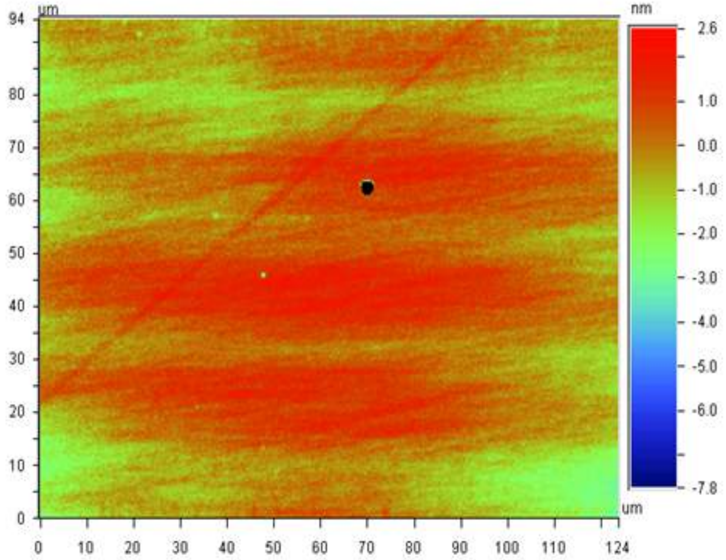
200 мкм

Roughness Ra, µm

Measurement	**Before MAP**	**After MAP**	
		20 passes	**30 passes**
1	2.897	0.328	0.024
2	2.761	0.413	0.021
3	2.555	0.382	0.029
4	2.671	0.384	0.040
5	2.437	0.685	0.040
6	2.634	0.623	0.034
7	2.666	0.449	0.026
8	2.664	0.325	0.038
9	2.660	0.379	0.098
10	2.788	0.510	0.052

Examples of details for MAM





Optics

Ra = 0,14 nm = 1,4 À

Laser ceramics

Ra = 1.537 nm

Si-wafers for electronics

Ra = 0.72 nm

Examples of details for MAM




Tools:

cutters, punch, drills

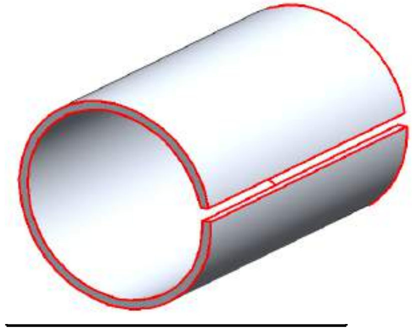


Pipes:

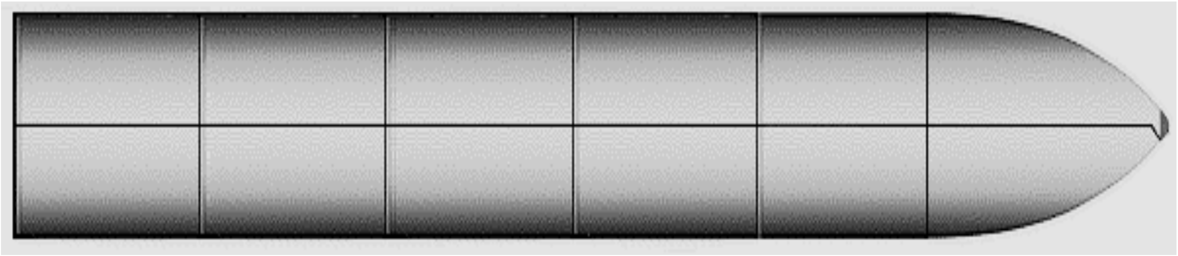
external and internal surfaces


Envelopes of fuel rods of nuclear reactors

Examples of details for MAM

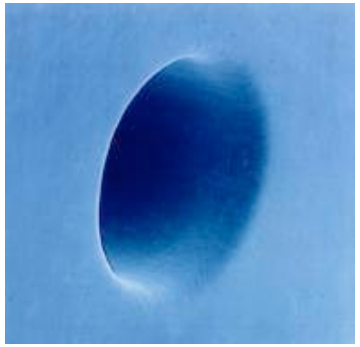


Cleansing edges before welding



Cleansing of surfaces of details for aviation, space, ship and other industries

Polishing aviaturbine blades



Removing burrs and edges rounding

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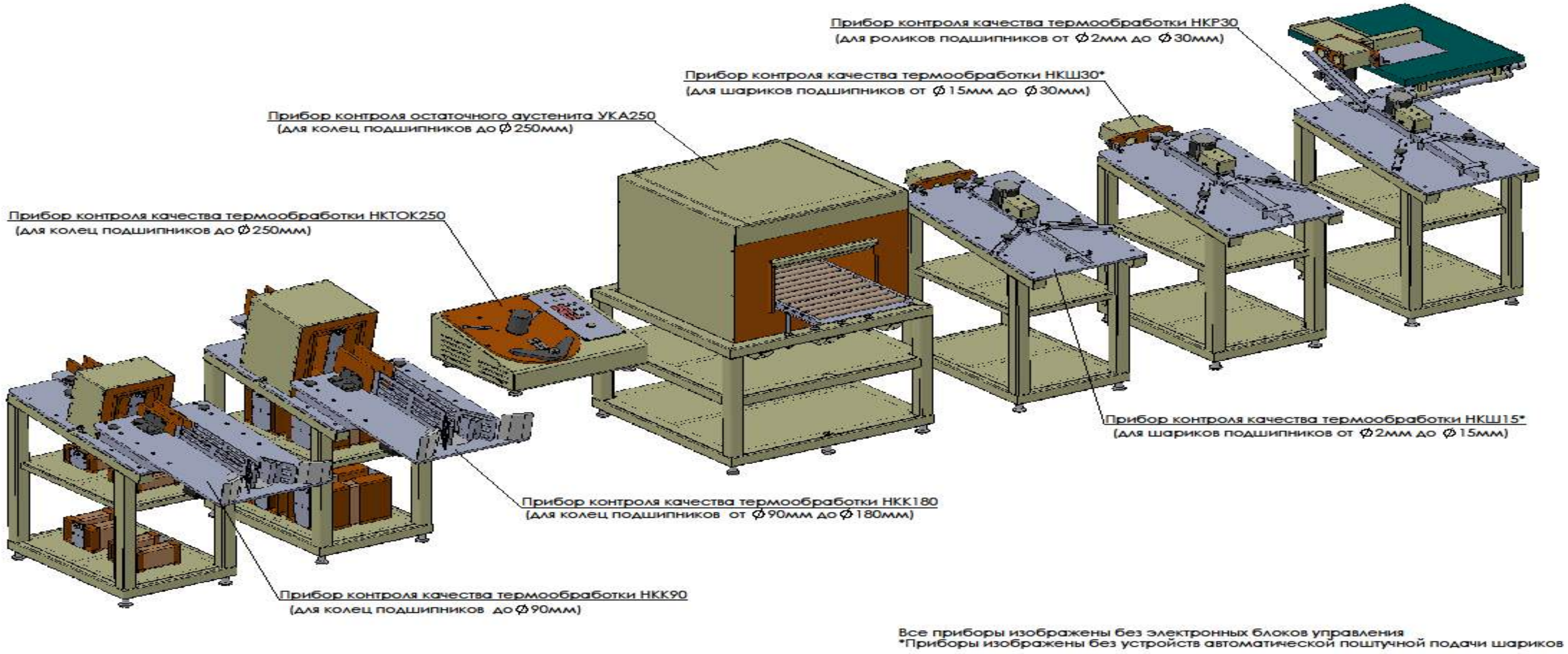
Instruments for quality control of bearing components after heat treatment



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