NANOTECHNOLOGY

WIDE SPECTRUM
OF MACHINING
MATERIALS

ENVIRONMENT-FRIENDLY
TECHNOLOGY

ACCURACY

PRODUCTIVITY

QUALITY
SURFACE

INDEC™

TECHNOLOGIES AND EQUIPMENT FOR HIGH-PRECISION ELECTROCHEMICAL MACHINING

WWW.INDEC-ECM.COM

About the company

«ECM» LLC – is **a** Russian manufacturer of hi-tech electrochemical machines for precise machining of parts made of metals and alloys.

«ECM» was **f**ounded **i**n 2009 with the participation of **the** RUSNANO corporation.

Founders of «ECM» LLC are: individuals — the team of authors and key developers of technology and equipment for pulse electrochemical machining and financial investors.

«ECM» LLC group of authors has more than a 30-year-old practical experience in the field of electrochemistry. During this period it has created 12 serial models of electrochemical machines, mastered and put into operation more than one hundred technological processes in Russia and abroad, published 7 monographies, about 300 scientific and technical articles, it has registered more than 100 patents for inventions.

The registered trade mark of the Company is:

INDEC™

[1] ECM — is abbreviated from ElectroChemical Machining.

Activity:

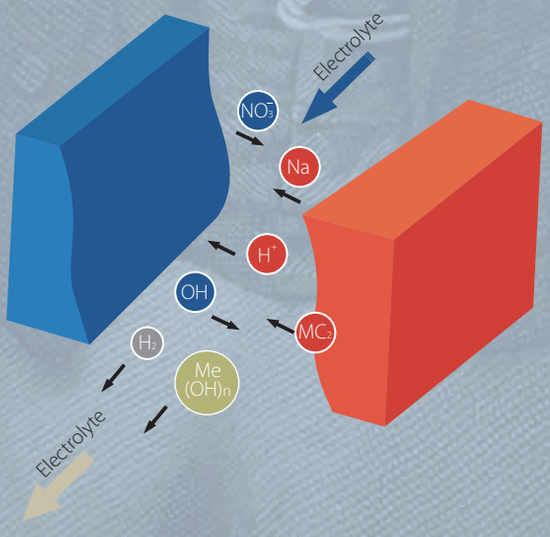
- Development of new electrochemical machines and technologies
- Serial production of electrochemical machines
- After-sales service and warranty repairs
- Design technological supervision of customers: development of original technologies, tooling, control software for processing of parts by the "ET" series machines
- Execution of orders for manufacturing of parts on the electrochemical machines

Understanding of electrochemical machining

The physical principle of electrochemical machining (ECM) is based on high-speed anode dissolution of metals and alloys under high density electrolysis current of in flowing electrolyte at small electrode gaps. Thus according to Faraday's law, **the** weight of the material removed from the workpiece is proportional to the current intensity and machining time.

For realisation of the ECM process two metal electrodes (the tool and workpiece) are placed against each other **with** a small gap filled with electrolyte and connected to opposite poles of **the** technological current supply. The negative pole is connected to the tool (cathode) and positive pole is connected to the workpiece (anode). Electric current flowing between anode and cathode through electrolyte generates electrode processes: cathions recovery at the cathode, metal oxidation at the anode.

For example, in case of the electrochemical machining of steel parts in water solution of neutral salt $NaNO_3$ which molecules are dissociated for nitrates-ions NO_3 - and sodions Na + the process of dissolution of the workpiece (anode) material proceeds in the following sequence:



There is a process of ionisation of metals Me = {Fe, Cr, Ni...} at the anode which in the simplified form looks like this:

$$Me \rightarrow Me^{z+} + z \cdot e^{-}$$

Metal ions Mez + co-operate with OH - ions with formation of hydroxide of Me (OH) n type which are **precipitated** in the form of **a** sludge. It is taken out from the electrode gap by flowing electrolyte and is removed by means of filters or separators.

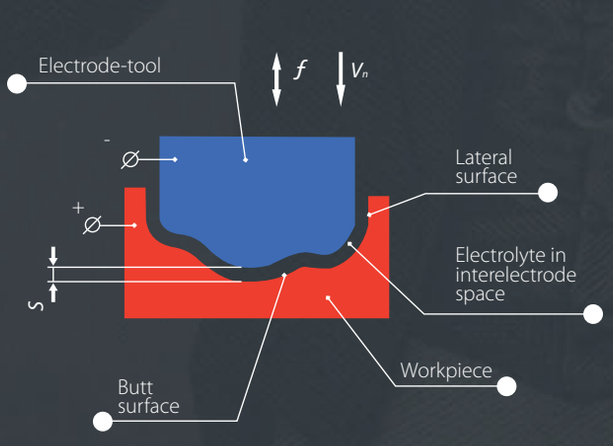
Decomposition reactions of water molecules with formation of gaseous hydrogen **occur** at the cathode.

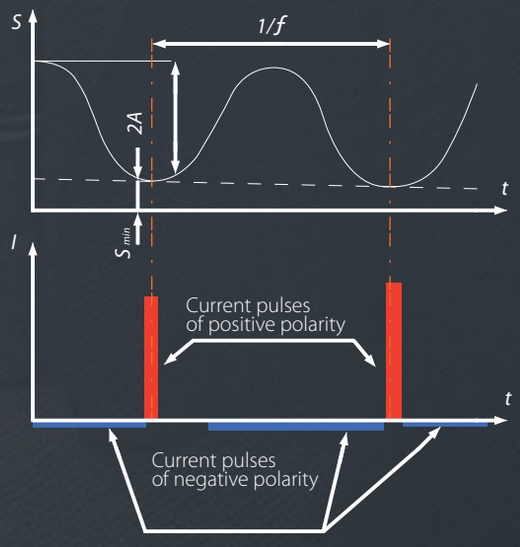
Sodions Na + due to very low electronegative values of their equilibrium potentials are not restored and formally do not take part in the process.

In theory, only water is consumed except for the electric power during the ECM.

ET-technology of electrochemical machining

The distinctive feature of the new ET-technology of electrochemical machining developed by "ECM" LLC, is that groups of microsecond bipolar pulses of high density current are synchronously supplied to the oscillating electrodes located in the electrolyte fluid at the points of their approach to the minimum electrode gap. It allows to **greatly** improve the localization of **the** anode dissolution reaction.





Competitive advantages of ET-technology

General description of ET-technology

The branded ET-technology of pulse electrochemical machining according to complex criterion «accuracy- roughness -productivity» surpasses the majority of modern methods **for** finish machining of parts. The achieved roughness results (to Ra 0,01. 0,002) and resolution at copying (<10 micron) allow to exclude traditional finishing operations: finish grinding and polishing.

The ET-technology, as well as **the** traditional technology of electrochemical machining, is «cold», that is**, it is** not associated with any considerable heating of the surface and changing of its structure, there is no mechanical contact of the tool and workpiece in the course of machining, and the most important thing is complete absence of the tool wear.

During one operation it is possible to make precision copying and surface finishing.

Independence of target technological indicators of the ECM method from physical - mechanical properties of the processed material allows t**he** process**ing off** both tempered, and non-tempered steels.

Thus after machining there are no burrs and sharp edges **which** in most cases **removes the need** to hand work, or to exclude from technological processes the corresponding operations.

Machinability

It is possible to carry out machining of practically all groups of constructional steels and alloys used in industry, including high-**tensile** steels and alloys, metal-ceramics, intermetallic compounds, **and** nanostructure alloys.

Unique parts machining

Machines of the «ET» series allow to make unique, complex parts made of high-tensile steels and alloys with special micro-structurization of the surface (for example, turbine blades of the «sharkskin» type; bio-implants; scalpels for microsurgery; compression molds for precision instruments industry).

Absence of the tool wear and its physical contact to a part allows to process low-stiffness, thin-walled and delicate.

Productivity

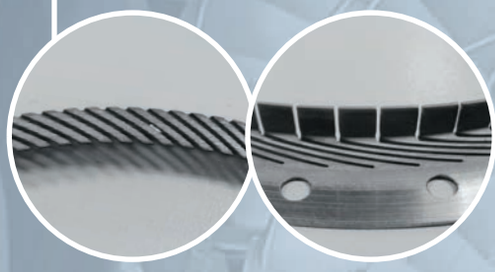
The ET-technology machine provides precise and finishing shaping 2... 10 times faster, than competing technologies (for example, EDM and multiaxis high-speed milling).

Automation

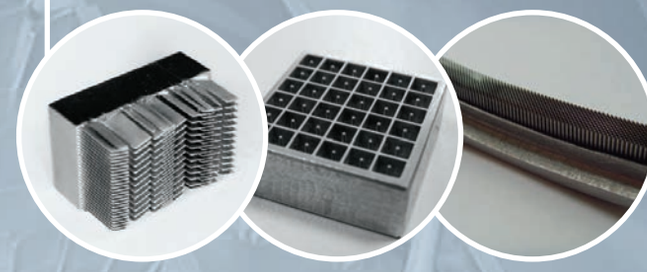
- The convenient software and the intellectual interface allows for the operation of the machine without special training.
- Machine can be adjusted under manufacture of any parts by change of the machining program and industrial equipment.
- Remote control of the technical status of the machine is possible.

Turbine/Aerospace

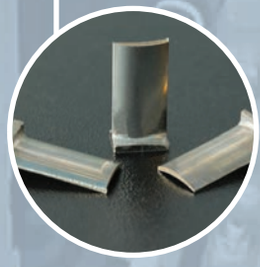
Broaching of narrow grooves in rings of finger seals for air-to-air and air-oil cavities



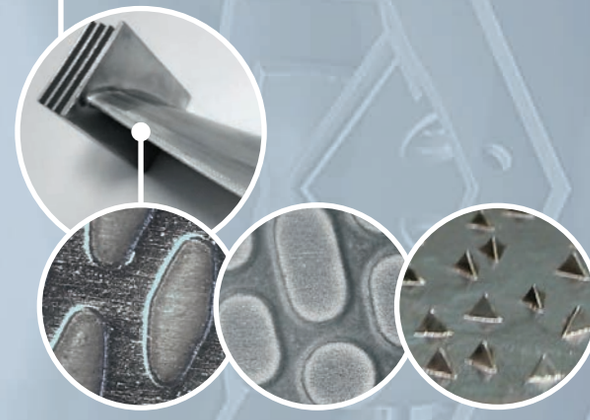
Manufacturing of cellular and labyrinth seal of air-to-air cavities



Formation of aerodynamic and pull end of small compressor blades from titanium, aluminium, intermetallic alloys and heat-resistant steels

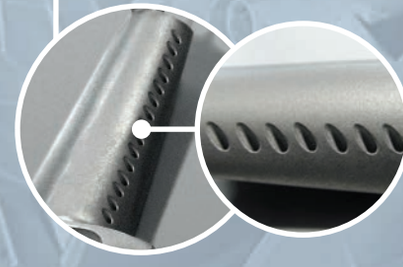


Applying of the "sharkskin" type regular surface microreliefs on compressor and turbine blades

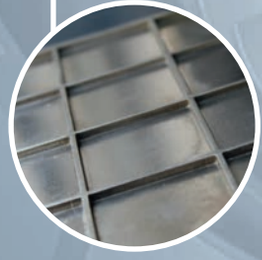


Manufacturing of highly loaded gear wheels (including nonsymmetrical cogs, herringbone, hypocycloid) from high-tension steels and alloys

Broaching of highly effective cooling and functional apertures (including the inclined and complex profile ones) in blades and other parts of turbines and flame tubes

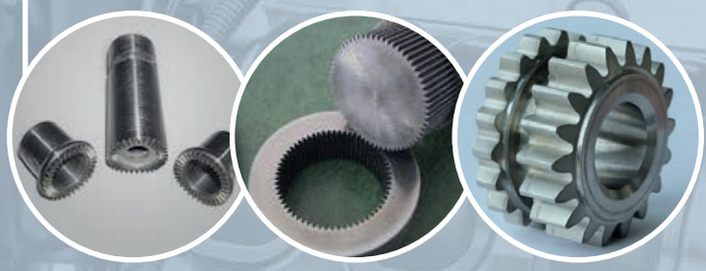


Wafery design made of heat resisting alloy

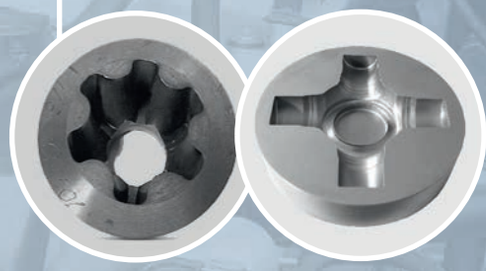


Automotive

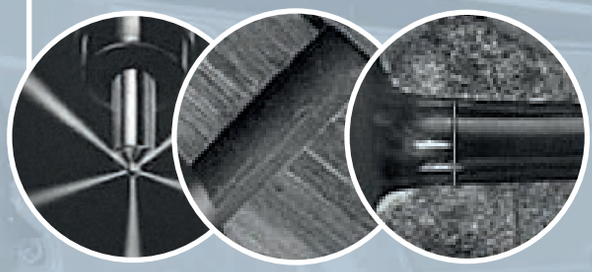
Gear wheels for cylindrical, hypoid and bevel gearings, sealing ends and spline joints



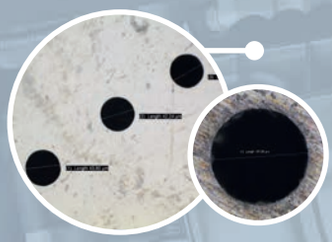
Swage die manufacturing



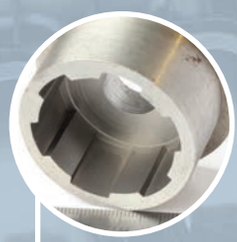
Small holes for oil inlet in bearings, broaching of small holes in injection nozzles



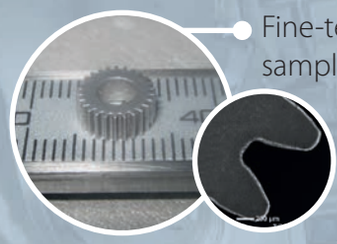
Instrumentation



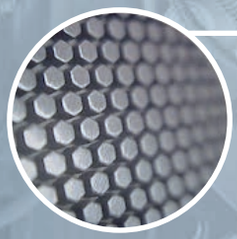
Microapertures of Ø 40 micron in a stainless steel foil of 50 micron thickness



Spline coupling

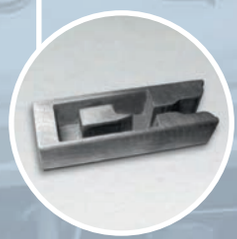


Fine-teeth gear sample



Regular hexagonal ledges (radius of inscribed circle 0,5 mm)

Flowmeter sensor

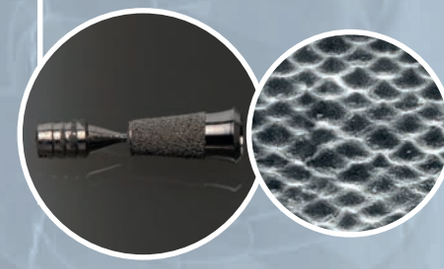


Complicated hole pattern in stainless steel

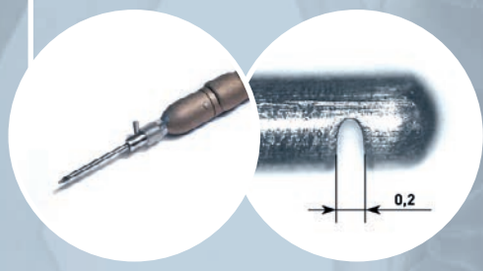
Medicine

Macroform and a sharp cutting edge formation (less than 1 micron) of medical tools for microsurgical operations (scalpels, choppers, prechoppers, splitters)

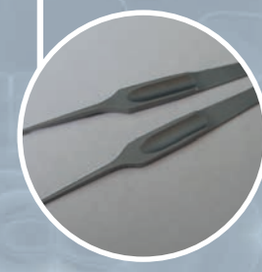
Manufacturing of steel and titanium implants with complicated surfaces and regular microrelief (endosteal and dental implants)



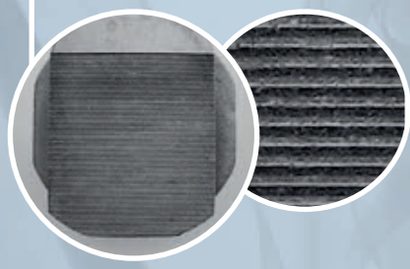
Broaching of narrow grooves and apertures of small diameter in medical tools and devices (for example, vitreotoma tips, probes, cannulas for irrigation, microcaptures)



Element of bipolar tweezers

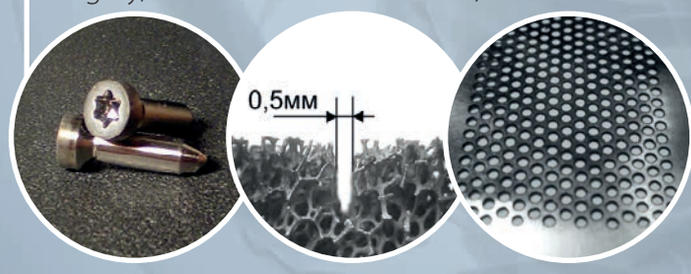


Manufacturing of steel and titanium implants with optically smooth shaped surfaces



Manufacturing of steel and titanium implants having optically smooth shaped surfaces

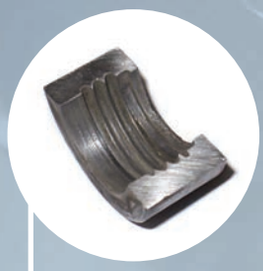
Sizing (various grooves, apertures, cavities broaching) of implants (for example, plates for cranial-maxillofacial surgery, vertebrarium surgery, medical nails and so forth)



Jaw dissector made of stainless steel

Tools manufacture

CONSUMER GOODS



Molds for plastic products

Molds for foot-wear

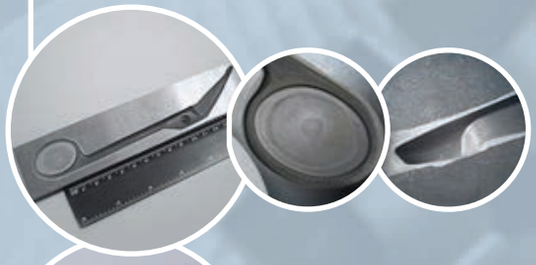
JEWELRY INDUSTRY

Medallion foundry mold

Die for badges

MEDICINE

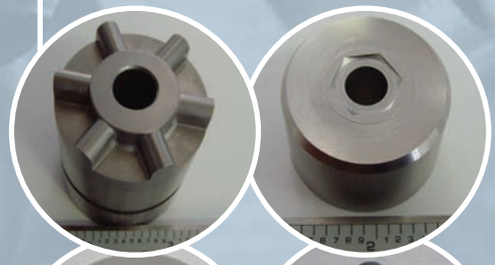
Forceps press-tool



Punch for tablets formation

FASTENING PARTS

Punches for metalware

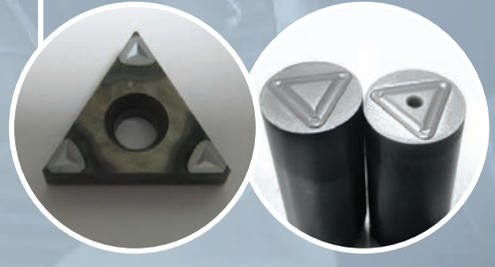


AUTOMOTIVE MANUFACTURE

Molds for hydro apparatus parts

MANUFACTURING OF HARD-ALLOY CERAMIC-METAL TOOLS

Hard-alloy tools with recovered relief



Machines of the «ET» series

Electrochemical machines of **the** «ET» series (ET200/ET 500/ET1000/ET3000/ ET6000- 3D) are intended for precise electrochemical machining of parts made of **hardened** tool steels, titanium, nickel, copper, hard WC-Co alloys, magnets, nanostructure alloys, etc. In 2011 special electrochemical machines - вET 8000-2D and sET6090-3D **were** developed and put into a batch production.

Machines of the «ET» series are compact and free-standing, environmentally safe. They can effectively be applied for parts manufacturing of aircraft and motor vehicle engines, press molds, matrixes, centre punches, foundry molds, medical apparatuses, human implants, parts of precision instruments, jewels and many other things.

The whole range of «ET» series machines is certificated for the Russian Federation and the European union countries!

Structure of electrochemical machines of «ET» series

The basic components of «ET» machines:

1. Mechanical system
2. Pulse generator and automated CNC control system of technological process
3. Hydraulic system (for refining, regeneration and supplying of electrolyte fluid to the machine)
4. Cr6+ removal system (optional delivery)

Mechanical system

Rigid design, modern drives, precise guides, optical linear sensors provide high accuracy, repeatability and sensitivity of **the** electrode-tool **position**

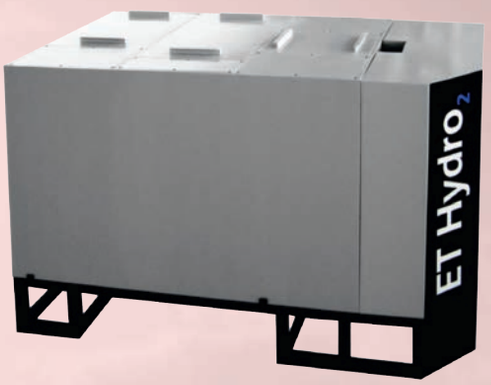
Pulsed power supply

The Pulsed Power Supply for PECM with integrated air cooling generates high **current** pulses of microsecond duration and pulses of negative polarity. Modular design facilitates various power ratings with any ratio of positive and negative polarity currents. The Pulsed Power Supply has high efficiency, low noise, high reliability and serviceability.

CNC control system

Allows **automatic operation of the process through** the set technological program. It has a convenient graphic**al** human-computer interface. It carries out functions of machine systems diagnostics with **the** possibility of remote control and adjustment.

Hydraulic system



A closed independent system of supplying, refining and regeneration of electrolyte fluid with the automatic control and regulation of its physical and chemical properties.

Ecological system (Option)

The closed independent system for automatic removal of Cr^{6+} ions from electrolyte fluid.

ET6000-3D

Three-axis -controlled electrochemical machine

The electrochemical machine of ET6000-3D type has 3 controlled axes and is intended precise die-sinking and hole-contouring technological operations, consisting of transitions on machining of several surfaces co-ordinated relatively to each other, and also the standard measuring transitions necessary for automatic positioning of electrode-tool relatively to a workpiece.

Machine ET6000-3D technical characteristics:

Work Table Size, mm	450×400
Maximum workpiece dimensions (LxWxH), mm	350×300×250
Number of axes	3 (X, Y, Z)
Maximum axis travel, mm	200, 150, 250
Maximum vertical daylight, mm	300
Rapid movement speed, mm/min	300
Processing feed rate, mm/min	0,001…1
Z-axis increments, mm	0,001
Maximum amperage in a pulse, A	6000
Maximal workpiece weight, kg	50
Maximal electrode-tool weight, kg	5

ET3000 series

Electrochemical die-sinking and hole-contouring machines

Electrochemical die-sinking and hole-contouring machines of **the** ET3000 series are intended for **the** execution of precision die-sinking and hole-contouring technological operations. The most advanced **technology** in the field of precision electrochemical machining **is** used in the machines**. This** allows **the** process **of** parts with high technological indicators from a wide range of metals and alloys, including titanium, heat resisting alloys, metal-ceramics and nanostructure materials.

Machine ET3000 technical characteristics:

Work Table Size, mm	450×400
Maximum workpiece dimensions (LxWxH), mm	350×300×250
Number of axes	1(Z)
Maximum axis travel, mm	250
Maximum vertical daylight, mm	300
Rapid movement speed, mm/min	300
Processing feed rate, mm/min	0,001…1
Z-axis increments, mm	0,001
Maximum amperage in a pulse, A	**3000-7000**
Maximal workpiece weight, kg	75
Maximal electrode-tool weight, kg	7,5

ET1000 series

Electrochemical die-sinking and hole-contouring machines

SAME AS ET3000 Electrochemical die-sinking and hole-contouring machines of ET1000 series are intended for execution of precision die-sinking and hole-contouring technological operations. The most advanced technical decisions in the field of precision electrochemical machining are used in the machines that allows to process parts with high technological indicators from a wide range of metals and alloys, including titanium, heat resisting alloys, metal-ceramics and nanostructure materials.

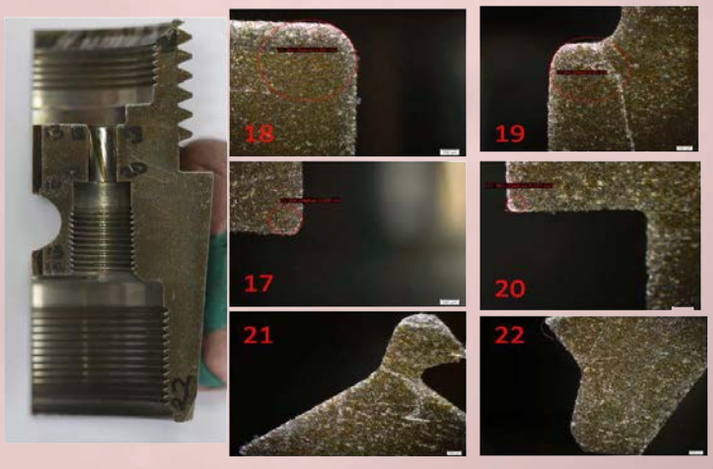
Machine ET1005-1/ET1010-1 technical characteristics:

Work Table Size, mm	250×250 / 320×320
Maximum workpiece dimensions (LxWxH), mm	150×150×100 / 220×220×150
Number of axes	1 (Z)
Maximum axis travel, mm	150/150
Maximum vertical daylight, mm	250/250
Rapid movement speed, mm/min	300
Processing feed rate, mm/min	0,001…1
Z-axis increments, mm	0,001
Maximum amperage in a pulse, A	500 / 1000-**3000**
Maximal workpiece weight, kg	25/ 25
Maximal electrode-tool weight, kg	5 / 5

ECD-204

Electrochemical machines ECD series for deburring and rounding of sharp edges

ECD series machines are designed for electrochemical deburring and rounding of sharp edges on parts from various metals and alloys (steel, aluminum, titanium, brass, etc.).



Example of a detail, in section, after the deburring operation

Eco-2

Independent automated system of ions Cr^{6+} removal from electrolyte fluid

Eco-2 system of various standard sizes and productivity is intended for **the removal of** Cr^{6+} **ions** from the spent solutions of the electrolyte fluids used at the electrochemical equipment (electrochemical die-sinking and hole-contouring machines, machines for electrochemical removal of whiskers and marking and etc.).

The Eco system is completely independent and capable **to** work in an automatic mode. **The** Eco system can work **as** directly during the machine operating time, and when the basic machining equipment is switched off, for example during lunch or night time. Eco system can work **as** independently with any type of the equipment for electrochemical **machining, and** integrated into the c**ontrol** system of «ET» series machines.

ET500 series

Desktop electrochemical die-sinking and hole-contouring machines

Machine ET500/ET500L technical characteristics:

Work Table Size, mm	250×250
Maximum work piece dimensions (LxWxH), mm	150×150×100 / 150×150×200
Number of axes	1 (Z)
Maximum axis travel, mm	70
Maximum vertical daylight, mm	150 / 250
Rapid movement speed, mm/min	200
Processing feed rate, mm/min	0,001…1
Z-axis increments, mm	0,001
Maximum amperage in a pulse, A	500
Maximal workpiece weight, kg	10
Maximal electrode-tool weight, kg	1

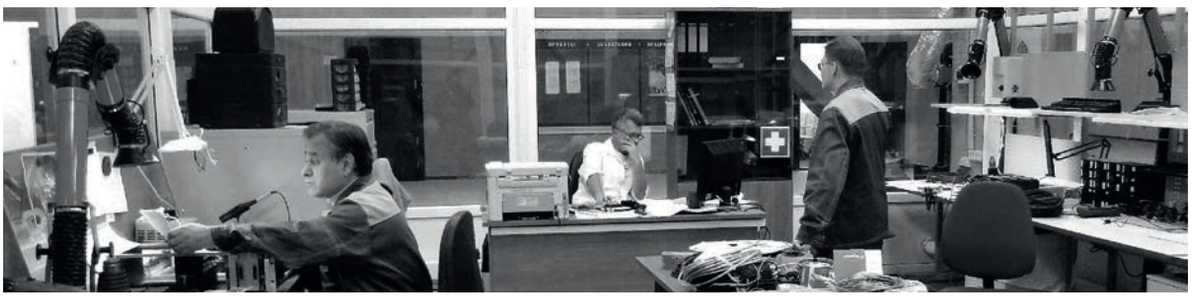
The company today

The company personnel includes 49 **people**, including: 1 Doctor of Engineering Science, 8 Candidates of Science (Engineering), 38 highly skilled engineers and technicians.

The production site in Ufa has **a** flexible design - industrial infrastructure and is equipped **with all the** all necessary modern industrial equipment, instrumentation technology and software.

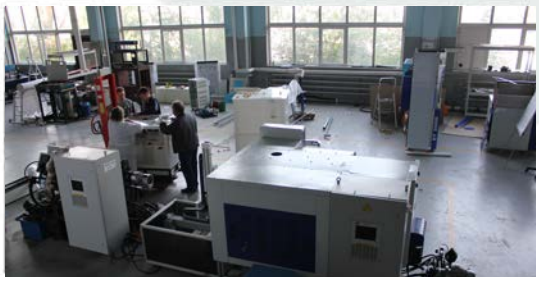
The infrastructure of the central production site includes:

- Design divisions (design, electrotechnical, software and control systems);
- The assembly and adjustment of original electronic modules section;
- Department of service, guarantee and post-guarantee service;
- Exhibition of the finished technological projects and samples of parts.



- Measuring laboratory with 6 co-ordinate measuring instrument, microprofilometer, measuring microscope, electronic microscope and etc.

• Technological department with the laboratory of the electrochemical analysis, 2 machines of ET series, EDM machine Sodick AG400L, EDM machine AgieCharmilles, milling-engraving machine Roland MDX540S, units of glass powder and ultrasonic cleaning.

·Two production lines for manufacturing, assemblage and testing of «ET» series machines.


All kinds of software design, measurement and working out are conducted with application of licence software products.

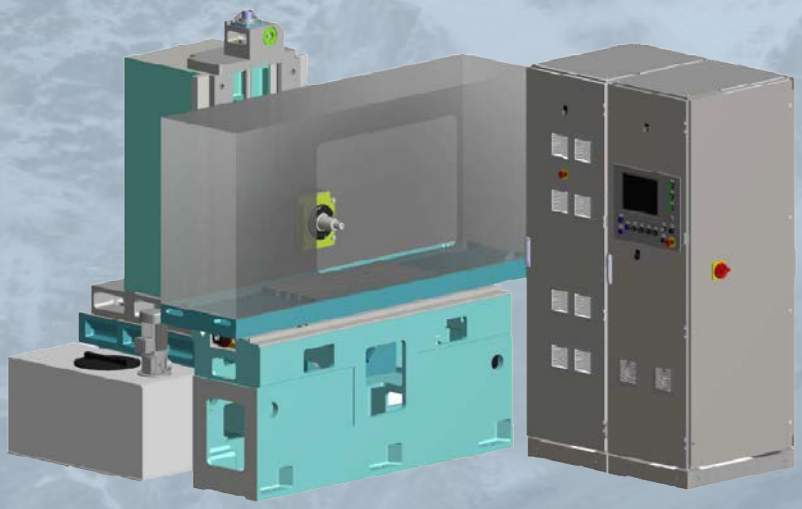
CEO
Dolgushin Aleksey



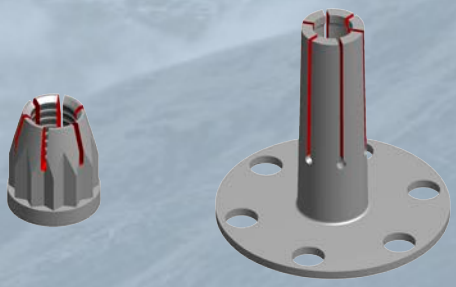

EAG-400/800

DIAMOND-ELECTROCHEMICAL CUTTING MACHINE

The machine is designed for electrochemical cutting with diamond parts from hard and titanium alloys.
The scope of the machine is for serial and small-scale production.



Details for EAG400 (800)
materials: corrosion-resistant steel 95X18, 14X17H2, 20X13
name of parts:
"Self-locking nut", "Bushing"



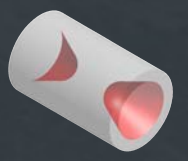
	Parameters, μm.
Tolerance of the flatness of the working surface of the table (convexity is not allowed)	no more than 10
Straightness of the trajectory of moving the table vertical and horizontal planes	lengthwise - 8 transversely - 5
The constancy of the angular position of the table as it moves in the longitudinal and transverse directions (at a length of 1000 mm.)	lengthwise - 20 crosswise - 10
Constancy of the distance between the trajectory of moving the table and the side the surface of the guide groove (at a length of 500 mm.)	10
The perpendicularity of the trajectory of the transverse displacement of the table to direction of its longitudinal displacement (at a length of 160 mm.)	20
Radial runout of the base surface of the grinding spindle under the circle	2,5
Axial runout of the grinding spindle	3
Parallel axis of rotation of the grinding spindle in relation to the working surface of the table (at a length of 300 mm.)	12
The perpendicularity of the axis of rotation of the spindle of the trajectory longitudinal displacement of the table (at a length of 150 mm.)	5
Straightness and perpendicularity of the vertical trajectory grinding head to the working surface of the table in the transverse direction (at length 300mm.)	16
Processing cleanliness, μm.	2.5…20
Processing accuracy, μm.	0,1

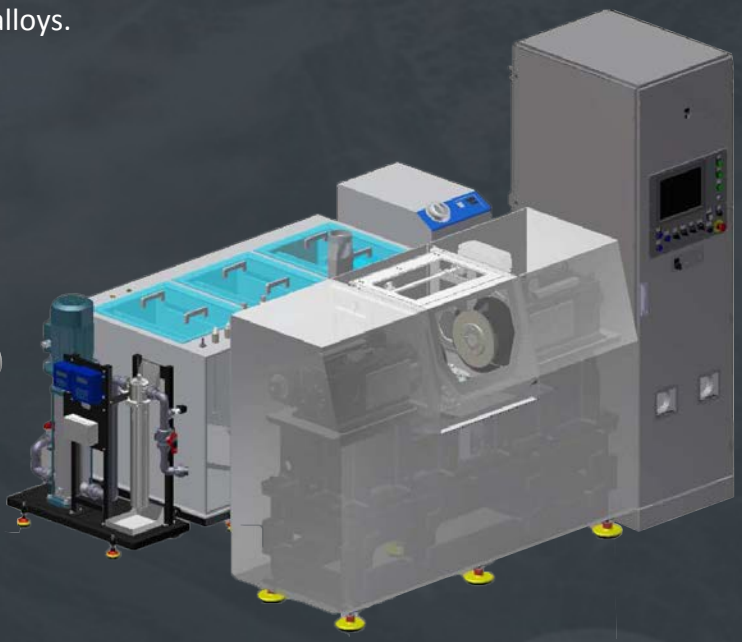
sET 1005-3D

Electrochemical machine

sET1005-3D
It is intended for processing of details on round and/or rotating parts constructional, heat-resistant, hardened steels and alloys.
It is intended for the machining of features in rotating parts manufactured from Heat resistant, hardened steels and alloys.

Details for sET1005-3D
Material: alloys XH73, XH56
Details name: "Support", "Corps"
Parts of fuel equipment





Type of blank
Two types of parts:

- "Support"; It is processed with axial feed of EI and continuous rotation of the workpiece.
- "Filter housing"; It is processed with a radial feed of the EI, the rotation of the workpiece It is used as an installation coordinate.

Length mm not more than	150
Max length	150
Width (diameter) mm no more than	150
Workpiece weight kg no more than	5
Changing the workpiece:	- exactly the right one
Dimensions of the workpiece processing area:	
Length mm not less than	320
Width mm not less than	320
The greatest distance between the end of the electrode holder and a rotation axis of at least	150 workpiece mm

ET3030-2D series

Electrochemical die-sinking and hole-contouring machines series ET3030-2D

Special electrochemical two-axis machine model sET3030-2D has 2 simultaneously controlled coordinates and one setup. Created for performance of multi-side bilaterial machining of parts for the fuel equipment in gas turbine engines.

Example of a detail, in section, after the deburring operation

Technical characteristics of the base model of the machine series sET3030-2D

Dimensions of the working space of the camera (LxWxH), mm	800 x 650 x 600
Limit dimensions of the workpiece (Diameter × Length), mm	40×160
Number of controlled coordinates	3(Z, Z', Y)
Electrode stroke, mm	150 each
Range of feed rates of electrodes, mm / min	0,001...6
Accuracy of counting movements along the Z axis, mm	0,001
The maximum current in the pulse, A	2500
Maximum direct current, A	900
Maximum workpiece weight, kg	20
Maximum mass of tool electrode, kg	3
Area occupied by the machine, m2	16,2
Maximum power consumption, kW	35

Our dealers

In Africa:
ALFA Lab.
Tel: +919842245779
Skype: sabareealfa,
Manager: Sabaree
E-mail: sabaree@alfaconsultancy.com

In Israel:
pECM Ltd.
Bazir St., 92/5, Karmiel.
ZIP: 2196305
Tel: +972(0)522973326
E-mail: info@pecm.co.il
www.pecm.co.il

In Iran
Mehr Techin Sepanta
Isfahan Science & Technologi Town,
Isfahan University of Technologi Blvd
P.O.Box: 84155/666 Isfahan, IRAN
Tel: +98 31 33860619,
Fax: +98 31 33862355
E-mail: international.affairs@istt.org,
mehrtechin-co@istt.ir
www.istt.ir

In Japan:
APC AEROSPECIALTY INC.
1-1-8-15, Iwamotocho, Chiyoda-ku, Tokyo
101-0032 Japan
Tel: +81-3-5820-1835;
Fax: +81-3-5820-1838
E-mail: overseas@apc-aero.co.jp
www.apc-aero.co.jp/index_english.html

INDEC™

TECHNOLOGIES AND EQUIPMENT FOR HIGH-PRECISION ELECTROCHEMICAL MACHINING

WWW.INDEC-ECM.COM

ECM, LLC
Legal address: 39, 50 let SSSR Street, Ufa, Russia, 450071
Mailing address: 39, 50 let SSSR Street, Ufa, Russia, 450071
Ph/fax: +7 347 246 27 82
E-mail: mail.info@indec-ecm.com
www.indec-ecm.com

Headquarters and Production Area
39, 50 let SSSR Street, Ufa, Russia, 450071