CRISM "Prometey"

Innovative developments of Central Research Institute for Structural Materials "Prometey" devoted to nanomaterials and nanotechnologies

Igor V. Ulin

1-st Global Nanotechnology Business Incubator Work Shop

June 8th-10th 2009, Jyvaskyla, Finland

RESEARCH-TECHNOLOGICAL COMPLEX FOR DEVELOPMENT OF STRUCTURAL NANOMATERIALS ESTABLISHED ON THE BASE OF FSUE CRISM "PROMETEY"

The aim of this complex was to form infrastructure of the national nano-technological network of the world level where it would be possible to carry out investigations and developments representing scientific resource for the home industry of structural nanomaterials

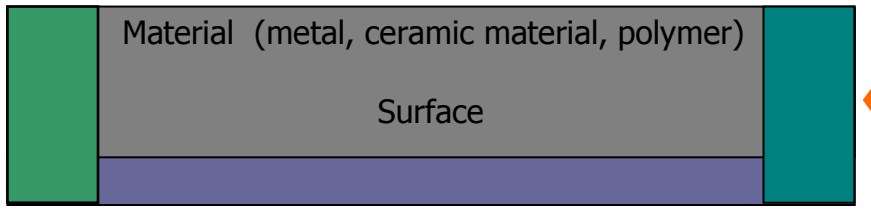
2007	Complex № 1	**Research complex for investigations of nanomaterials structure and properties, 1600 m²**
2008	Complex № 2	**Research complex for structural polymeric nanocomposites and experimental nano-technologies**
2009	Complex № 3	**Research complex of metallic nanocomposites**
2010	Complex № 4	**Research complex for manufacturing of structural nanomaterials using structure fragmentation methods**

BASIC APPROACHES TO MANUFACTURING OF STRUCTURAL NANOMATERIALS

Controlled creation of nanostructure within a material volume

(introduction of nanopowders, modification by outside effects)

Materials bonding (welding, soldering and so on)



Purposeful creation of a material (3-D designing, SRS synthesis)

(modification by outside effects, coatings application)

Nanostructurization of a material surface layers, material modification with nanostructured functional films and coatings

RESEARCH COMPLEX № 1 WORKING ON MODIFICATION OF NANO-MATERIALS SURFACE AND INVESTIGATING STRUCTURE AND PROPERTIES OF NANO-MATERIALS

(76 units of technological equipment)

Plant "DIMET 403" for supersonic cold gas-dynamic spraying

Computer manipulated (automated) complex "MPN-004" for micro-plasma spraying

Plant "Magna-TM 5" for magnetron spraying

Nanostructured functional coatings:
- **vibration absorbing wear-resistant**
- **volumetric-porous catalytic**
- **nanocomposites of electromagnetic protection systems**

Superspeed disintegrator of "DEZY- 11" type

Plant "PCP-1" for plasma-chemical synthesis

Plant "LENS" for laser synthesis

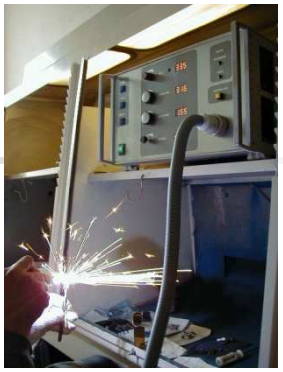
Plant "ELOP" for electro-chemical alloying of surface

NANO-STRUCTURIZATION OF TRADITIONALLY USED MATERIALS WILL ALLOW FOR CARDINAL IMPROVEMENT OF THEIR PROPERTIES FOR HUMAN CONSUMPTION

MANUFACTURING PROCESS OF WEAR- AND CORROSION-RESISTANT COATINGS USING METHOD OF MICRO-PLASMA SPRAYING

Technology of micro-plasma spraying

Computer manipulated (automated) complex for micro-plasma spraying



Micro-plasma spraying plant

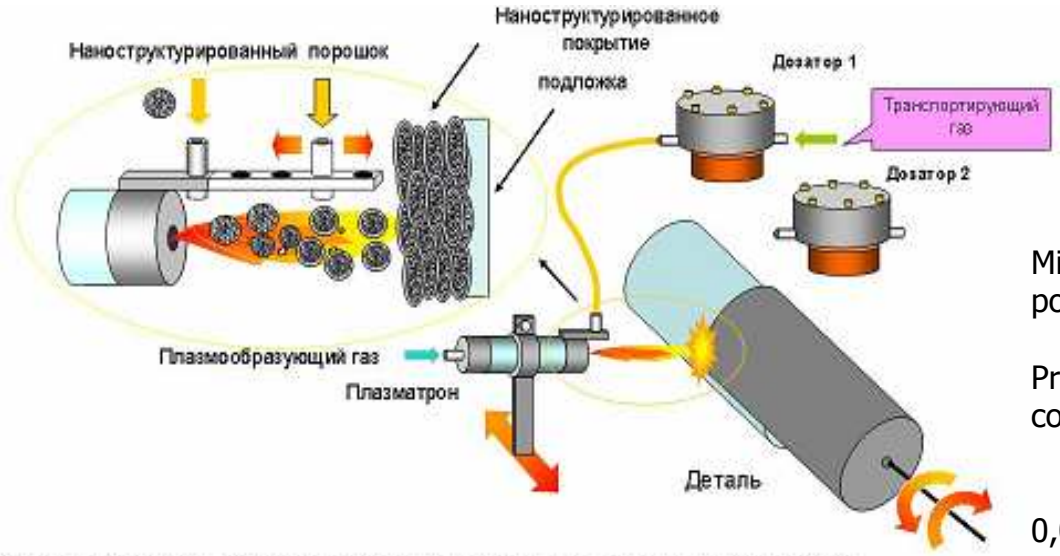
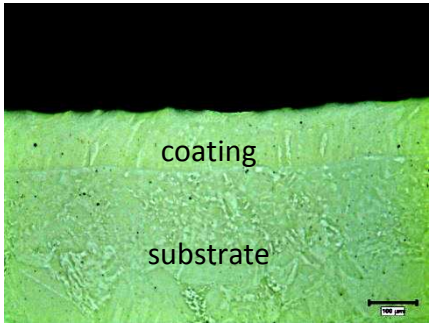


Схема технологического процесса микроплазменного напыления наноструктурированных покрытий

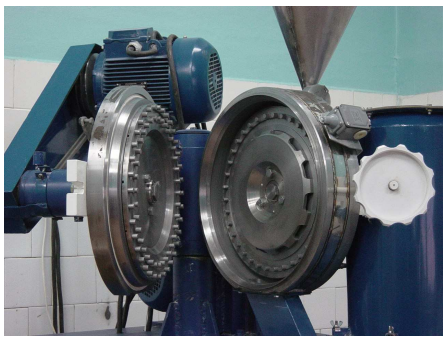


Microstructure of wear- and corrosion-resistant pore-less coating

Properties of wear- and corrosion-resistant coating:

- hardness 55 – 65 HRS
- corrosion speed in 3% NaCl solution - 0,073 mm/year

MECHANOACTIVATION TREATMENT OF MATERIALS IN DESINTEGRATING PLANTS



Advantages:

- Closed cycle and ecological purity in production
- disintegration (crushing) and activation at particles collision speeds 450 m/sec absence of alien inclusions
- performance (capacity) from 2 up to 200 kg/h depending of a plant type

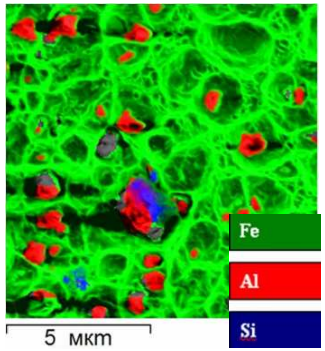
Fields of application:

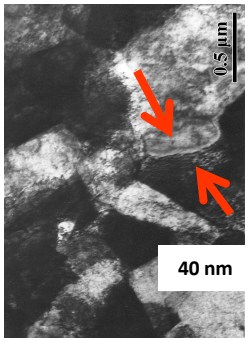
1. Fuel and power engineering complex, machine engineering
2. Production of metallic and oxide powders of different purposes
3. Food industry (biologically active nourishing mixtures and drinks for sportsmen and patients in the period of rehabilitation)
5. Agriculture (forage agents)
6. Pharmacology (drug substances of a specified dispersion for regulation of these substances dissolving speed and adsorption, low-toxic medicines with a specified biological accessibility and reduced effective dose)

RESEARCH COMPLEX № 1 WORKING ON MODIFICATION OF NANO-MATERIALS SURFACE AND INVESTIGATING STRUCTURE AND PPROPERTIES OF NANO-MATERIALS (6 units of unique research equipment)

Double-beam scanning ion-electronic microscope "FEI Quanta 3D FEG"

Resolution - 0,1 nm
Measurement local accuracy – up to 10 nm
Over 1000000 magnification

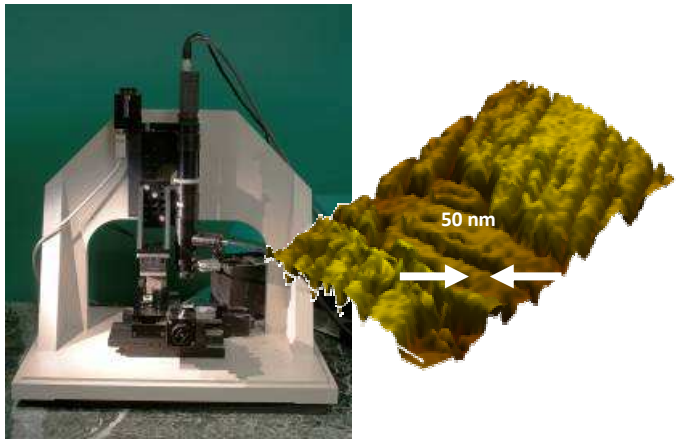




X-raying (translucent) electronic microscope "Tecnai G 2 30 S-TWIN"

Study of nanostructured materials allows for modernization of nano-size structures and control these structures formation

Plant "IFT-1500M" for investigation of internal friction in metals



Atomic-force microscope "Super Nanoscan"

Transit time mass-spectrometer with gas-discharge ionization "ЛОМАС 30"

SHIELDING AND RADIO-ABSORBING MAGNETIC SOFT NANO-COMPOSITES FOR WIDEBAND SYSTEMS OF MAGNETIC AND ELECTROMAGNETIC PROTECTION FOR NAVIGATION INSTRUMENT COMPLEXES AND CREWS

Fields of application:

- instrument and navigation complexes
- power cables
- individual protection of crew
- means of communication
- radiolocation and radio-navigation stations
- high-frequency plants, generators and amplifiers
- fire and alarm warning systems
- electronic measurement, monitoring and control of processes
- medical instruments and apparatus

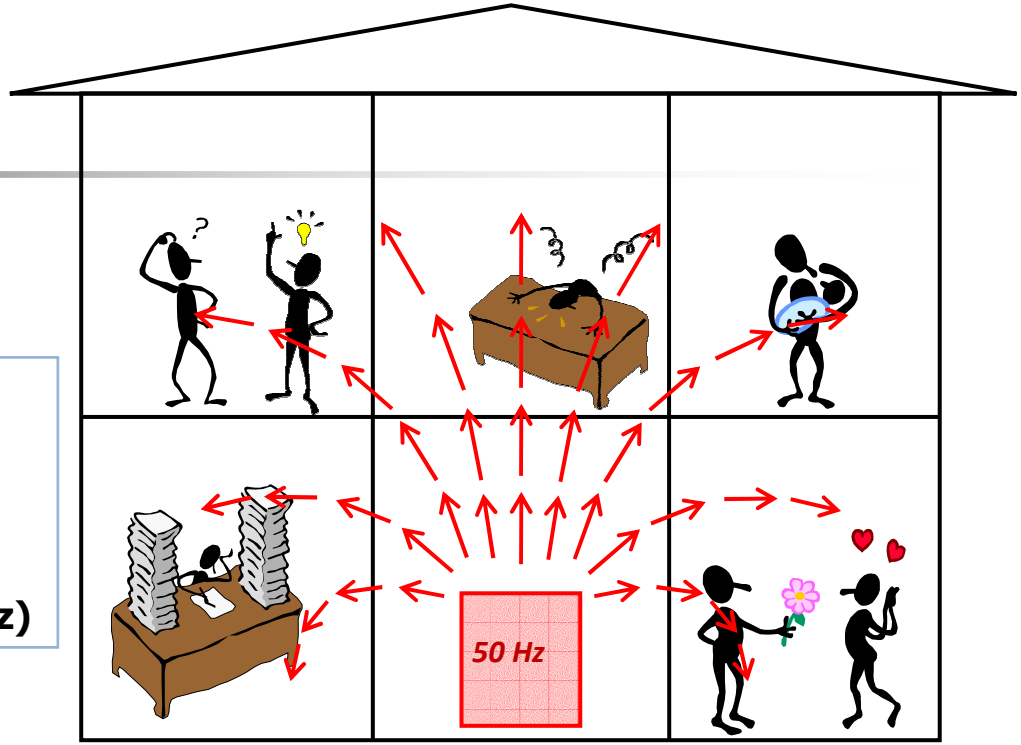
Individual protection of crew

(Shielded jacket)

Shielded rooms

Shielded power cables

MAGNETIC SCREENS USED FOR SHIELDING OF TRANSFORMER SUBSTATIONS BUILT IN DWELLING HOUSES



Affect made upon tenants of apartments adjacent to transformer substation:
acoustic noise
vibration
electromagnetic fields (especially from variable field of industrial frequency 50 Hz)

Number of built-in substations in St. Petersburg	**499**
Maximum permissible noise level of magnetic fields in apartment rooms *	**5 mkTl**
Actual magnetic field level in apartments adjacent to transformer substation	**40-50 MkTl**

SOLDERING WITH SILVERLESS AMORPHOUS SOLDERS

This kind of soldering is intended for bonding of metals (Ti, Mo, Cu etc.) as well as different steels and ceramic materials.
Soldering temperature is 650-1100◦C depending of material used in structure

Advantages of soldered joints are as follows:
1) high strength under permanent sign-variable vibration and impact loads (for titanium joints – up to 700 MPa, for steel joints – up to 800 MPa, for copper joints – up to 200 MPa);
2) high corrosion and erosion resistance;
3) vacuum tightness.

It is offered:
- a soldering technology for heat exchangers made of 07X18H10T steel with operating temperature up to 750◦C assembled of tube boards from 4 mm in thickness which are connected with tubes from 3 mm in thickness and wall thickness from 0,1 mm (number of tubes in heat exchanger is not limited);
- a soldering technology for heat exchangers made of titanium alloys operating in gas and liquid media;

This soldering technology is also recommended for bonding of composite half-finished products, parts and blades of gas turbines, working parts of pumps, vacuum structures, assemblies of domestic accessories.

WEAR- AND CORROSION-RESISTANT COATINGS APPLIED ON SHUT-OFF VALVES OF SLIDING SYSTEMS, TURBINE BLADES AND OTHER PARTS OF MACHINES WORKING IN AGGRESSIVE ENVIRONMENTS UNDER ENHANCED LOADS.

Fields of application:

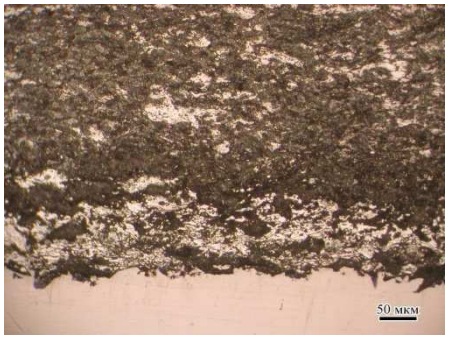
- fast-rotating parts of submersible in water, oil-less pumps and compressors;
- turbine blades and covering sheets with nanostructured ceramic composites to protect them from high temperature gas erosion;

for protection against corrosion in manufacturing of instrument panels, joint assemblies, manholes and so on);

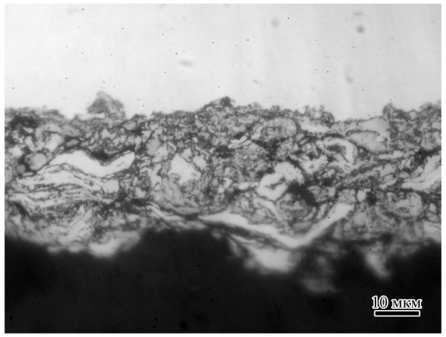
- diesel engine pistons for about 1,5-fold reduction in temperature of footing;
- fast-rotating parts of liquids dosing flowmeters;

gyroscopes instrument bedplates of enhanced rigidity due to usage of nanoceramic surface composites;

- parts of water pumps and shut-off valves of taps;
- ribs and floorings of aluminium steps.



Pores-free corrosion- and wear-resistant coatings (Fe-Mn-WC (SiC) system materials)



Functionally-gradient heat- and corrosion-resistant coatings (Al-Sn-Sn-WC system materials)

Corrosion-resistant coatings for risers on marine drilling platforms

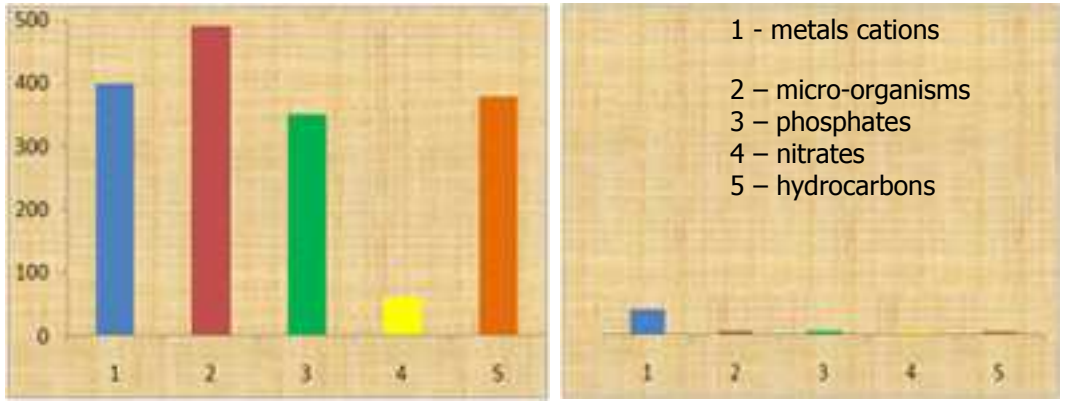
Wear-resistant coatings for bushes.

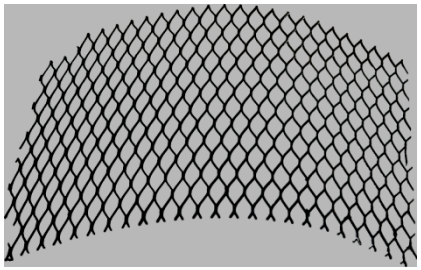
NANOMATERIALS- BASED EFFICIENT CATALYTIC SYSTEM FOR WATER PURIFICATION AND DEMINERALIZATION

Compositions and manufacturing technology of nanostructured coatings of (Ti-Ru)O system is developed for water catalytic purification and demineralization using magnetron detonation method. A range of "KASKAD" plants of up to 15 m3/h capacity used for water purification and demineralization systems, children's institutions, dwelling complexes, mobile hospitals and objects under protection of the Extraordinary Situations Ministry is developed. This plant provides efficient water purification from:

- all kinds of microparticles: bacteria, viruses, protozoa organisms (along with their vital activity products), humus and mineral particles, insoluble oil product particles.
- ions of heavy metals, phosphates, sulfides, nitrides, cyanides, phenols and so on.

Water purification degree





latticed (cellular) nanostructured cathode of "KASKAD" plant

magnetron spraying plant TF-600

water purification and demineralization plant "KASKAD"

Fields of application of nanocatalyzers

Water purification catalytic systems

Solution of passing gas utilization problem

Solution of ecological problems in industrial areas

Heat exchanging modules used in power units

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2259879

СПОСОБ ИЗГОТОВЛЕНИЯ КАТА… ЭЛЕМЕНТА

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Автор(ы): *см. на обороте*

Заявка № 2003126816

Приоритет изобретения 01 …

Зарегистрировано в Государс… изобретений Российской Фе…

Срок действия патента истек…

Руководитель Федеральной… собственности, патентам…

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2274914

МАГНИТНЫЙ И ЭЛЕКТРОМАГНИТНЫЙ ЭК…

Патентообладатель(ли): *Федеральное государственное унита… предприятие "ЦЕНТРАЛЬНЫЙ НАУЧНО-ИССЛЕДОВАТЕ… ИНСТИТУТ КОНСТРУКЦИОННЫХ МАТЕРИАЛОВ "ПРОМ… (ФГУП "ЦНИИ КМ "ПРОМЕТЕЙ") (RU)*

Автор(ы): *см. на обороте*

Заявка № 2004116728

Приоритет изобретения 01 июня 2004 г.

Зарегистрировано в Государственном реестре изобретений Российской Федерации *20 апр…*

Срок действия патента истекает 01 июня 20…

Руководитель Федеральной службы по инт… собственности, патентам и товарным зна…

Б.П…

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2273680

АМОРФНЫЙ МАГНИТОМЯГКИЙ СПЛАВ НА ОСНОВЕ КОБАЛЬТА

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Автор(ы): *см. на обороте*

Заявка № 2004124567

Приоритет изобретения 12 августа 2004 г.

Зарегистрировано в Государственном реестре изобретений Российской Федерации *10 апреля 2006 г.*

Срок действия патента истекает 12 августа 2024 г.

Руководитель Федеральной службы по интеллектуальной собственности, патентам и товарным знакам

Б.П. Симонов

COOPERATION WITH FOREIGN PARTNERS

A meeting with representatives of Finland FINODE and FINPRO was held with presentation of Nanocenter. As a result of this meeting an agreement of cooperation was signed on 15 December 2008 in the Committee of economic development and industrial policy and trade of St. Petersburg

Main provisions of the agreement are as follows:

Both sides will favor and promote cooperation for development and implementation into industries of innovation projects of northern and north-western regions including the following:

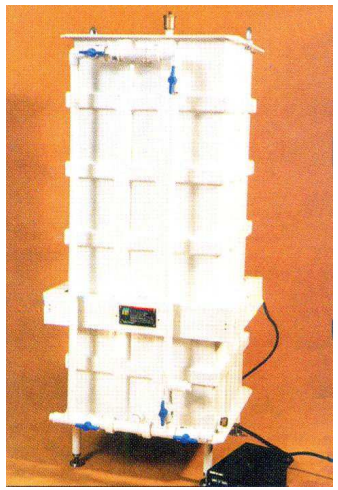
- organization and holding international scientific and technical workshops, conferences, symposia;

- organization and carrying out investigations and developments under projects of the 7th Frame Program of the European Union, TASIS programs and neighbour cooperation programs;

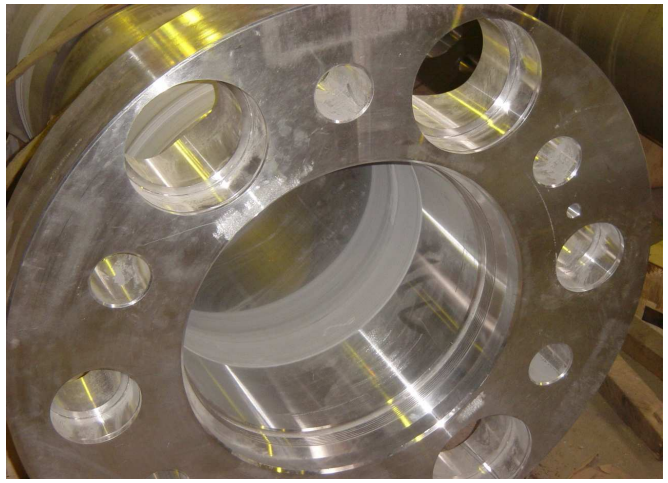
- exchange of know-how and rendering scientific-technical support in implementation of engineering and production innovations.

NANOMATERIALS- BASED INNOVATION PRODUCTS

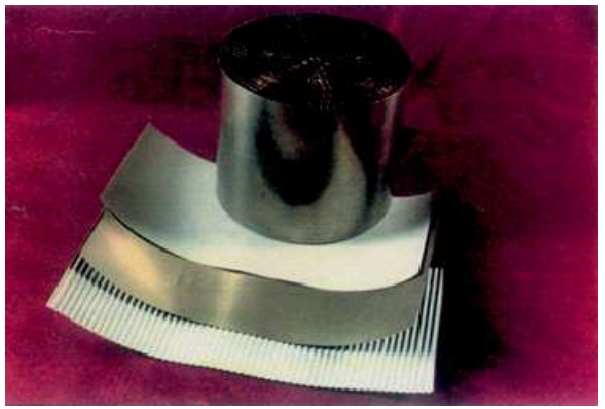
Coatings



Water purification systems



Corrosion-resistant:
- risers



Catalytic:
- toxic gases blow-out neutralizers