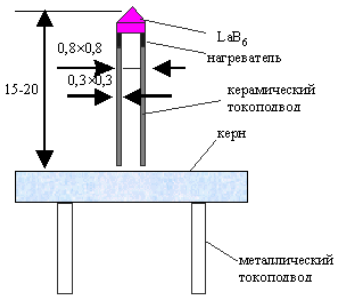
THE LANTHANUM HEXABORIDE (LaB_6) CATHODES FOR ELECTRON-BEAM DEVICES AND GAS-DISCHARGE SYSTEMS

Ukraine, Kiev, National Technical University of Ukraine "Kiev Polytechnical Institute"

The National Technical University of Ukraine "Kyiv Polytechnical Institute" offer the new types of the ceramic cathode units with the monocrystalline lanthanum hexaboride emitters, the high-quality structurally perfect monocrystals of the borides of the rare-earth metals, and the directionally reinforced ceramic materials. The principally new industrial technology of manufacture of the monocrystals of the borides of the rare-earth and the transitional metals is based on the method of the non-crucible zone smelting of the porous powder stocks with the movable solvent of the impurities. It allows to receive from the boride powder of the industrial purity during one crossing of a zone of the metal bath the crystals with the preset crystallographic orientation, diameter and with such a contain of the impurities that with the use of the contemporary technologies can only be received after triple crossing of a zone of the melting bath. For the first time in the world practice the increase of the efficiency of purification is received by means of use of the highly porous powder stocks and the solvent of the impurities. The said solvent moves inside the porous channels of the stocks and ensures the initial purification on the level of the separate particles of the high-melting material. The limiting stage of the technology indicative of its high efficiency is the duration of the process of manufacture of the crystal, which for receive of the crystal with the length of 180 mm and diameter of 4,7+0,1 mm does not exceed one hour. The new technology permits to manufacture up to 20 000 disc cathodes 1,5-3 mm high and 1-6 mm in diameter during two months. It also permits to manufacture from the monocrystallic hexaboride lanthanum the ceramic cathode units with the edged microcathodes.

Microcathodes for the Electron-Probe Analysis Instruments

There are offered the original design and the original technology of manufacture of the directly heated cathode units with the emitters made of monocrystallic hexaboride lanthanum which contain metallic conductors, ceramic cores, ceramic conductors, high-temperature heaters and emitters nondetachably bound in the process of welding and soldering that provides for stability and recurrence of incandescing, emitting and spatially-geometrical characteristics from cathode to cathode both at the stage of manufacture and in the process of durable operation.



The new cathode units differ from the existing analogs by the technology of manufacture. For the first time for their manufacture there were used conductors and heaters made of crystallized high-modulus eutectic alloys i.e. tenacious ceramics on the basis high-melting compounds, and technology of ensuring nondetachable physical and chemical thermostable contact between the structural elements of the cathode unit in the process of operation at the operational temperatures of 1400-1600 Centigrade, in the conditions of multiple and rapid heating and cooling.

The tenacious ceramics on the basis of high-melting compounds with big share of covalent ingredient of chemical bond does not exhibit a noticeable hyperthermal creep up to the temperatures of 0,5-0,8 Тпл that is considerably higher than in the metallic constructional materials and allows to maintain an emitting spearhead of the cathode in unchangeable position in the space with regard to electronic-optical axis of the cannon in the process of long-term operation.

High sturdiness (1400 MPa) and strain crack toughness (К1с= 24 MPa $м^{0.5}$) of such ceramics allows to reduce the sizes of the constructional elements up to a level of the sizes of the metallic elements (0,2-0,4mm) without danger of their destroy at the stage of manufacture and consequent use in the regemes of the uneven (irregular) heating and cooling, and also to reduce up to 8 watts the power costs of warming up of the cathode up to an operation temperature.

The Hexaboride Lanthanum Monocrystalline Cathodes for the Devices of Technological Purpose (welding, melting, welding deposition, heat treatment, high-precision dimensional treatment refractory and chemically active materials, lithography, tomography, pharmacology)

The monocrystalline LaB_6 cathodes used in the devices of technological purpose allow to get rid of several effects of unstable operation of polycrystalline cathodes bound with a developed grid of borders of grains, geometrical and chemical heterogeneity of an issuing surface, to increase power and spatially geometrical parameters of the electronic beams by means of use of an anisotropy of issuing properties of hexaboride lanthanum.

Application of the monocrystalline disc cathodes with orientation of an emitting surface (100) in the installations of welding without change of design, incandescing and spatially geometrical parameters of an electronic cannon allows:

- to increase up to 2-2,5 times the period of service of the cathodes in comparison with the polycrystalline hot-pressed cathodes;
- to increase up to 20-30% the electronic beam’s reserve in current;
- to reduce diameter of the beam and ensure stability of its geometrical dimensions in all range of changes of the parameters of the focusing devices of the electronic cannon;
- to increase the depth of fusion at the expense of increase of the specific power of the electronic beam for 20-25%;
- to reduce a heat load upon the constructional elements of the cathode unit and the cannon at large;
- to increase stability of a current and transversal diameter of electronic beam;
- to reduce thermal tensions in the welded material;
- to increase stability of the geometrical sizes and forms of a juncture.

Use of the Device in the Field of Welding Opens a Possibility:

In the Field of Welding

- to reduce welding strains, technological allowances for processing;
- to reduce predilection to creation of cracks in junctures;
- to weld diamond-containing cutters to the body details thanks to small thermal influence in the zone near juncture.

In the Field of Surfacing

- to considerably broaden possibilities of restoration and repair of the items of important purpose, in particular, of turbine blades;
- to minimize melting of the base metal, and to receive thin covers of materials with the special properties in case of directive trickling transfer of a metal.

In the Field of Heat Treatment

- to receive hardened layers (coats) tens of microns thick in the details of important purpose that operate in hard conditions (for example, cutting edges of the beet knives), that provide the first approach to the regime of self-sharpening;
- to carry out heat treatment in the hard-to-reach places, passing a beam through the small diameter channels.

In the Field of Cutting

- to carry out highly effective cutting of the robust constructional materials in the machine- and shipbuilding industry including cutting of the maid of titanium alloys thick walls' shells with a cutting speed of no less than 300-500mm/sec;

In the Field of Sized Processing

- to receive the orifices in the robust materials with the diameter from 10 to 100 microns with a regular arrangement that at present can not be received by any other methods.

In an Ecology

- Disposal of the toxic ecological dangerous oxides of nitrogen and sulfur from flue gases of thermal power stations, metallurgical and chemical manufactures.

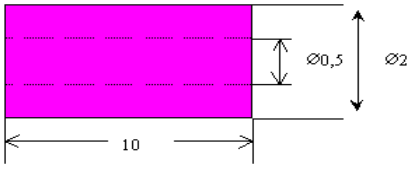
In Medicine

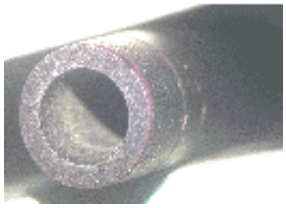
- Ensure high resolving ability X-ray tomographs.

Manufacturing of isotopes etc.

The Hexaboride Lanthanum Cathodes for the special Gas-discharge Systems

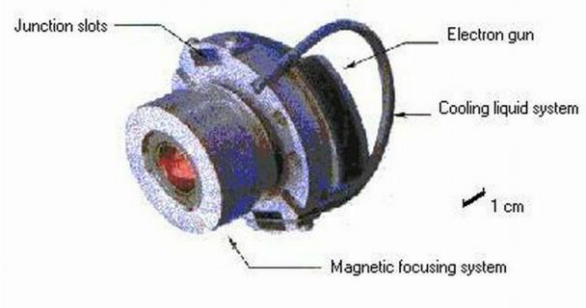
The Firm produces cathodes and cathodic-heating units with the hexaboride lanthanum emitters in the forms tubes, rings, pins and other articles more complicated in form using the methods of pressing (compacting) and subsequent sintering, plasma spraying and high temperature compacting of the pre-purified monocrystalline powder, and also by means of junction of the monocrystalline insertions into polycrystalline matrix (composite mosaic cathodes 3-4 mms thick and 120 mms in diameter).





Electron-beam units for high-vacuum technologies

The National Technical University “Kyiv Polytechnic Institute” (Ukraine) together with Institute of Radio-Physics and Electronics of the National Academy of Sciences of Ukraine suggest for the industrial application efficient low-cost high-perveance electron optical systems (EOS). These systems are intended for the vacuum fusion of materials, including the refractory materials such as Mo, Ta, W, etc., application of coatings and films, and other high-vacuum technologies based on the electrical heating of objects.



Pick power of the electron beam, kWt	40
Accelerating voltage, not less, kV	14
Diameter of the electron beam at the gun output, mm	6
Diameter of the focused electron beam at the target, at the trajectory distance 350 mm from the module, tunable, mm	10÷50
Current of the focusing system, A	1÷3
Heating power, not less, Wt	120
Cooling liquid consumption, l/min.	2
Weight, kg	1,0
Dimension, mm	Ø 90x100