# Physico-Chemical nanomaterials science Vapor-condensed composite materials Ni-$Al_2O_3$, NiCr-$Al_2O_3$ with oxide nanophase

Grechanyuk V., Grechanyuk M., Chornovol V., Kozyrev A., Kovalchuk Yu.
Kyiv National University of Construction and Architecture
missvik@ukr.net

## Introduction

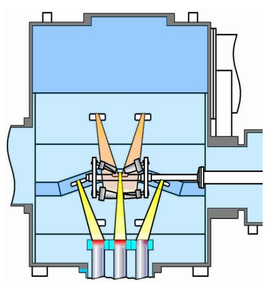
High-speed electron beam evaporation-condensation of EV-DVD, as a new progressive technological process, has found wide application for deposition of various types of protective coatings on products, first of all, for gas turbine blades. The rate of vapor flow deposition on substrates of various configurations can reach 150 μm/min. Therefore, it is of scientific and practical interest to use the specified technological process controlled at the atomic and molecular level to obtain massive (separated from the substrate) composite materials.

## Equipments

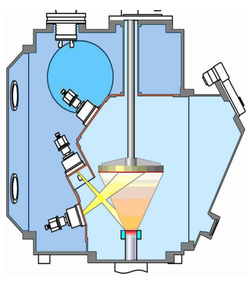
Composite materials are obtained on a universal two-chamber electron beam unit L-2 (Fig 1).

A feature of the installation is the possibility of carrying out on it, after a slight readjustment, four different technological processes:

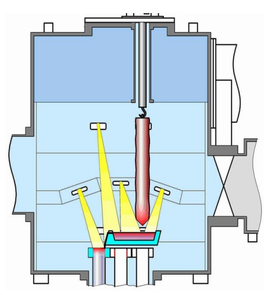
- deposition of TBC on turbine parts and other products;
- production of composite materials from the vapor phase;
- remelting and refining of metals and alloys in vacuum;
- powders production (experimental technology).



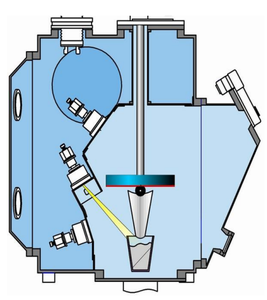
*deposition of TBC on turbine parts and other products*



*production of composite materials from the vapor phase*



*remelting and refining of metals and alloys in vacuum*



*powders production*

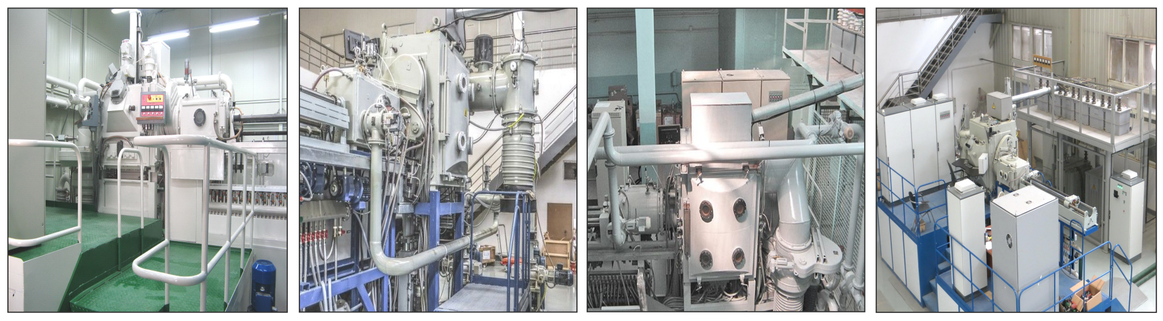


**Fig.1 Multipurpose Laboratory Electron Beam Equipment L-2**

*1. N.I. Grechanyuk, P.P. Kucherenko, A.G. Melnik, I.N. Grechanyuk, Y.A. Smashnyuk, V.G. Grechanyuk Neu electron beam equipment and technologies for producing of advanced materials using vacuum melting and evaporation methods developed at spe eltekhmash / // The Paton Welding Jornal. – 2016. – № 5-6. – P. 48-55.*

*2. N. I. Grechanyuk, V.G. Grechanyuk, E.V. Khomenko, I. N. Grechanyuk, V.G. Zatovskii, D. Kovalchuk The new condensed from vapor phase composite materials based on copper and their applications // Electrotechnica & Electronica. – 2016. – № 5-6. – P. 199-205.*

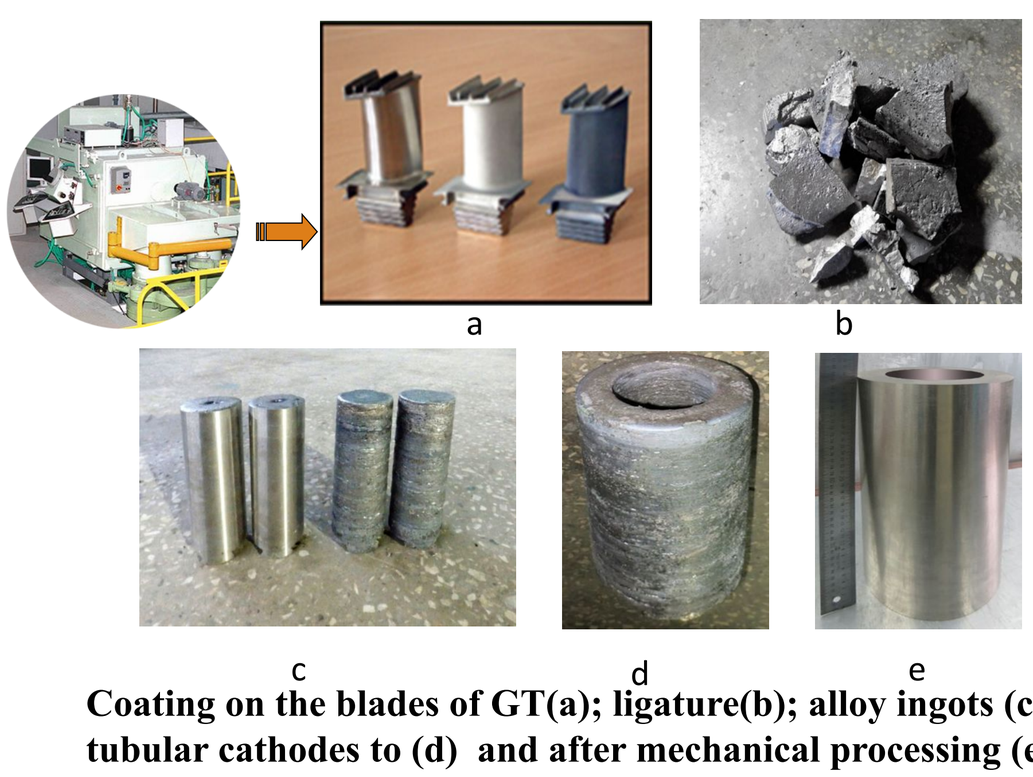
3. *I.N. Grechanjuk, V.G. Grechanjuk, L. Orac* Corrosion resistance in neutral saline fog of the composites Cu-Mo obtained by PVD method / // Metallurgy and Materials science. – 2009. – № 5. –. P 297-304

## Results and discusion

Currently, intensive research is being conducted into new composite materials condensed from the vapor phase with a reinforcing refractory nanophase (oxides, carbides, borides, refractory metals). Dispersion-strengthened composite materials condensed from the vapor phase (condensates) consist of a polycrystalline metal or ceramic matrix with nanodispersed particles of the second phase evenly distributed throughout the volume. By varying the temperature of the substrate and the rate of deposition, it is possible to change the average size of the crystallites of the matrix from several hundreds of microns to several hundred nanometers, and the size of the particles of the strengthening phase - from tens of nanometers to several microns. As a result of the influence on the morphology, dispersion and nature of the distribution of the strengthening phase, it is possible to obtain a combination of properties unattainable in ordinary alloys in dispersion-strengthened materials.

The use of stable refractory compounds as strengthening phases, for example, oxides that do not actively interact with the matrix metal and do not dissolve in it up to its melting point, ensures preservation of microheterogeneous structure and dislocation substructure up to pre-melting temperatures. This allows you to preserve the long-term performance of materials up to (0,9-0,95) $T_{melting}$.

Composite materials Ni-$Al_2O_3$; NiCrAl-$ZrO_2$; NiCr-$Al_2O_3$ condensed from the vapor phase, is used in new types of heat-insulating coatings on gas turbine blades; for the production of special materials from powder alloys; for coatings applied by ion-plasma and electron-beam methods; for the production of special alloys (fig.2)




**Coating on the blades of GT(a); ligature(b); alloy ingots (c); tubular cathodes to (d) and after mechanical processing (e)**