

PROTECTIVE AND DECORATIVE VACUUM'S COATINGS ON WARES OF ARTISTIC CASTINGS

V. GRECHANYUK, I. GRECHANYUK, N. GRECHANYUK

Kiev National University of Building and Architectures
 Kiev, Ukraine

ABSTRACT

The problem of environmental protection is extraordinarily important, and its actuality will increase with every year. In this aspect, processes of depositing of coatings in vacuum have got serious advantages before wide-spread galvanic method, as the last requires building of the special cleansing building, which cost in general balance of covering's process can arrive till 60 %. It should be noted that preliminary preparation of surface which, as is generally known, has the important value at the method of metallization in vacuum often execute by the smoldering discharge (by the «dry method»).

KEYWORDS: vacuum coatings deposition, electron-beam melting.

Methods of deposition of coatings in conditions of rarefaction (vacuum), depending on the features of transformation of material of coating in the vaporous state with subsequent condensation on the protected surface it is possible to divide into three kinds: cathode sputtering, thermal spray, and ion plating [1].

What from the indicated methods of coating's deposition in vacuum has definite advantages and failing. So, the method of cathode sputtering, differing by large universality, is limited comparatively by low speed of depositing of coatings. Thermal spray in vacuum is characterized by high performance, but had the substantial failing – low coefficient of the using of evaporated material. The method of the ion plating, allowing to obtaining of coatings with high degree of homogeneity of their thickness and with good adhesion with basis, is limited by difficulty of stabilization of plasma's discharge, and difficult equipment.

Most expressly criterions of progressiveness of any technological process are formulated in paper [2]:

- 1) universality, possibility of conducting of major of operations of production cycle by the identical technological receptions;
- 2) continuity of row of technological operations of production cycle in combination with group treatment of wares or billets;
- 3) high speed of conducting of basic operations of technological process, possibility of their intensification;
- 4) reproduced of parameters of every operation and high percent of output of suitable wares;
- 5) well technological construction, responding to request the automatic-ability of producing;

6) formalization, possibility of drafting of mathematical description (algorithm) of every technological operation with subsequent creation of the automatically system of technological process control;

7) competitiveness of process and possibility of quick to reconstruct the equipment for making of new types of wares without substantial expenditures.

Attempt of quantitative comparison of different methods of coverage's deposition in vacuum made by authors of paper [3], thus in each of methods their varieties are taken into account. Comparison of different methods of coverage's deposition is conducted on properties of the got films (degree of purity, density, adhesion, accordance of composition of films and evaporated alloy and etc.); on the technological features of process (sizes and form of substrate, speed of condensation, operative of process, substrate's temperature, time of cycle and etc); on the features of material, which coatings are obtained from, including cost and coefficient of using, and also - the cost of equipment.

The results of the indicated comparison taking into account present development of methods of coverage's deposition are resulted in the table 1. The following five-mark's system of estimation of the compared methods is chosen:

- 1) the index 5 indicates on the highest quality the tapes, most high technological and lowest cost;
- 2) the index 4 means that in a process the tapes of good enough quality can be got, a process is technological and the equipment has a low cost relatively;

- 3) the index 3 means that the considered method takes some advantages either as tapes, or in the technological features of process, or in its economy;
- 4) the index 2 indicates that the compared aspects of process are already found on verge of unacceptability of them for practical realization;
- 5) the index 1 means complete useless or unacceptability of the given method from point of one or another from the compared descriptions.

Analysis of resulted showed in table 1 data of testify of methods of thermal spray and ion plating are satisfied to all basic criteria of progressiveness. It, in particular case, behaves to the continuous processes of metallization. Of course, the resulted data in table are very relative, however a research value is unquestionable, as it allows to conduct the correct choice of method for the concrete case.

Table 1. Comparison of different methods of coverage's deposition in vacuum

Description of the compared methods	Thermal spray			Cathode (ion) plating		Ion plating			
	resistive method of heating	electron-beam method	explosive evaporation	radio frequency dispersion	same + negative potential on substrate	direct voltage		radio frequency	
						resistive method of heating	electron-beam method	resistive method	electron-beam method
A. Property of films:									
- degree of purity	3	4.5	3	5	5	3	4	3	4
- density	3	4.5	3	4.5	5	4	4	5	5
- adhesion	3	4	3	5	5	4.5	4.5	5	5
- homogeneity	3.5	3.5	3.5	4.5	4.5	5	5	5	5
possibility to cover the details of difficult type	2	3.5	2	4.5	4.5	5	5	5	5
possibility to obtain from alloys	1	3	5	5	5	1	3	1	3
B. Features of technologies:									
- size and shape of substrate	5	5	5	3	3	4.5	4.5	4.5	4
- holder of substrate	3.5	3.5	3.5	5	5	3	3	2.5	2
- application of masks	5	5	5	2	2	4	4.5	4	4
- speed of deposition	4	5	4	2	2	4.5	3.5	3.5	3
- complexity of operations	5	3.5	4	4	3.5	5	5	5	5
- motion, moving of substrate	5	5	5	1	1	1	2	5	2
- temperature of substrate	2.5	3	2.5	3	3	5	5	5	5
- time of cycle	3.5	3.5	3.5	2.5	2.5	5	5	5	5
- time of alteration of process	5	4	3.5	3	3	5	3	3	3
C. Material of coatings:									
- required form and shape	5	5	3	2.5	2.5	5	5	5	5
- coefficient of using	5	5	2	2.5	2.5	5	5	5	5
- cost	2.5	3.5	4	5	4.5	2.5	3	2.5	3
D. Cost of equipment	5	3.5	4.5	2.5	2.5	4	3.5	3.5	2

Electron-beam influence on metals, resulting in their heating, melting and evaporation, as a new technological direction in area of material's treatment intensively develops from middle of the XX century. Essence of process of electron-beam influence is that kinetic energy of formed that or other method

electronic bunch (impulsive or continuous) grows into thermal in the area of treatment.

Because the ranges of power and concentration of energy in the electron-beam are great, it is possible receipt of practically all types of thermal influence on materials: heating to the set temperatures, melting and evaporation with ever-higher speeds.

Presumably, history of process of electron-beam influence begins from 1852 year, when U. Grove in the lecture read in Royal Scientific Society, first indicated on possibility of the electron-beam heating. The first electron-beam melting of platinum anode in a cathode-radial tube was shown at 1879. At

that time it was not known yet, that cathode rays were the stream of electrons. At 1907 the first Patent on the process of the electron-beam melting of metals is given out.



Fig. 1. General view of EB-coating unit L-1

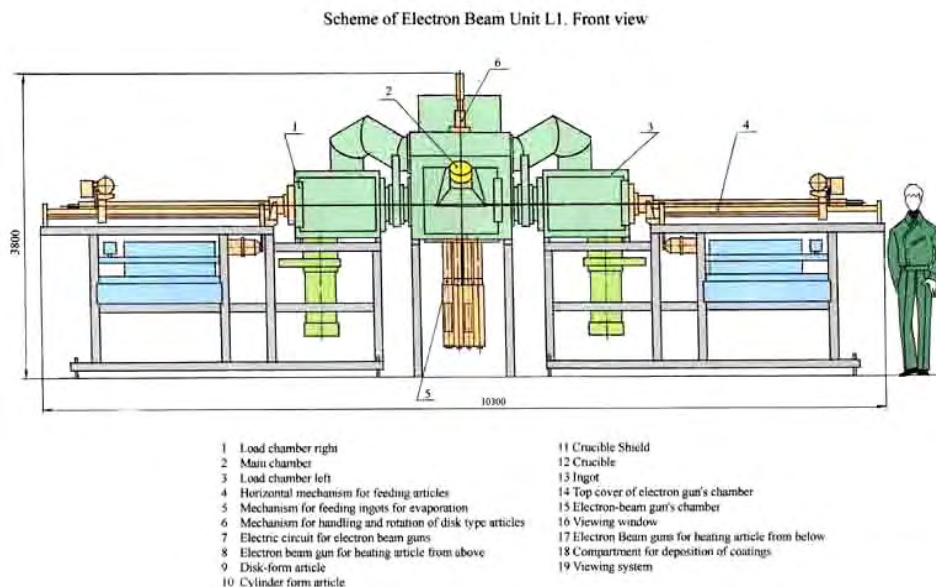


Fig. 2. The scheme of EB-coating unit L-1.

In Scientific-production enterprise «GEKONT» the industrial electron-beam unit L-1 for deposition of protective and decorative vacuum's coatings on different wares is developed. Photo of equipment is showed on fig. 1.

The scheme of equipment is showed on the fig. 2. The technological scheme of equipment is showed on the fig. 3. Technical descriptions of facility is resulted in the table 2.

Table 2. *Technical parameters of the industrial EB-coating unit L-1*

Denomination:	L-1
1. Dimensions of evaporated articles (ingots), mm diameter length, max	70 500
2. Dimensions of surfaces of condensation, mm right-angled plane round plate (diameter) cylindrical: diameter length	550 × 360 750 200 550
3. Distance from evaporation's surface to condensation's surface, mm	250...400
4. Number of crucibles	4
5. Lifting capacity of horizontal shaft for bringing of articles, kg	30
6. Lifting capacity of vertical shaft, kg	100
7. Power, kW transformer accessory devices	250 85
8. Accelerating voltage, kV	20
9. Quantity and power of EB guns for evaporation materials from crucibles for heating of articles from above for heating of articles from below	4 × 60 2 × 60 2 × 60
10. Level of vacuum in working chamber, Pa	$6 \times 10^{-3} - 1 \times 10^{-2}$
11. Discharge of cooling water (15°C), m ³ per hour	20
12. Power-supply circuit's voltage (frequency 50 Hz)	380
13. Dimensions of facility, m in plane height	10.5 × 10.5 3.8
14. Weight of facility (valuation), ton	30

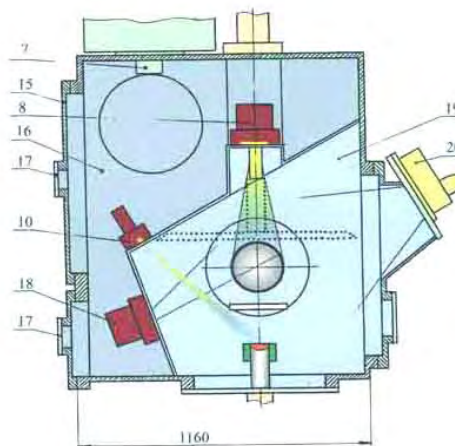


Fig. 3. *The technological scheme of EB-coating unit L.*

EB-equipment is the block of vacuum chambers with mechanisms, devices and systems providing conducting of technological process of coating's deposition on different billets. In the working chamber are located 4 crucibles for evaporation from them of materials of coatings. Evaporation of materials from each of crucibles is produced by the separate individual-guided EB-heaters. Two auxiliary chambers are intended for locking of heated billets. Disjoining of volumes of chambers is produced by 2 vacuum valves. The presence of two auxiliary chambers multiplies productivity of setting. Deposition of coatings on the billets given by turns from two auxiliary chambers takes place without unvacuuming of working chamber. The control by work of equipments is provided by in manual or automatic modes

Presently on the given equipment in industrial scales, are depositing of protective and decorative coatings on different billets from aluminum, copper, nickel, chrome is carried out, aluminum and chromic bronzes by a thickness from 10 till 300 mcm.

References

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