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Application of the vacuum method to obtain graphite

Avliyakulov Khayot Nodirovich
Probationer Teacher Bukhara Engineering-Technological Institute
Bafoev Bakhrom Botirovich
Probationer Teacher Bukhara Engineering-Technological Institute
baxa410159@mail.ru

Annotation. The article discusses the conceptual requirements for deposition methods widely used in modern microelectronics. The high deposition rate and the atomic energy incident on the substrate during deposition allow these methods to be used to obtain films with various compositions and structures, especially for low temperature epitaxy.

Keywords. Thermal spraying, resistive spraying - layered system, defect, composite, nanostructured coating, high-strength composite ceramics.
Thin films deposited in a vacuum are widely used in the production of discrete semiconductor devices and integrated circuits.

Obtaining high-quality and reproducible in terms of electrical parameters thin-film layers is one of the most important technological processes for the formation of structures of both discrete diodes and transistors, and active and passive elements of the.

Therefore, the reliability and quality of microelectronic products, the technical level and economic indicators of their production largely depend on the perfection of the film deposition process.

An important step is the control of film parameters (deposition rate, thickness and uniformity, surface resistance), which is carried out using special equipment, either during a separate technical operation or at the end of the process.

The purpose of the work: is to obtain thin films of graphite by sputtering using a universal vacuum post VUP-4

The following tasks were set

1. consider the general principles and methods of thin film deposition,
2. understand the device and principle of operation of the steam-oil diffusion and rotary vane pumps,
3. master the universal vacuum post VUP-4,
4. to overhaul the pumps and the vacuum system of the VUP-4 post,
5. Carry out test experiments on deposition of thin films of graphite on various substrates.

The subject of the research is the methods of applying thin films in various ways on any surface. The process of applying thin films in a vacuum consists in creating (generation) a flow of particles directed towards the processed substrate, and their subsequent concentration with the formation of thin-film layers on the surface to be coated[1]

Thermal spraying: The essence of this process of applying thin films is to heat the substance in vacuum to a temperature at which the kinetic energy of the atoms and molecules of the substance, which increases with heating, becomes sufficient for them to detach from the surface and spread in the surrounding space.

The evaporation process is carried out according to the usual scheme: solid phase - liquid phase - gaseous state. Some substances (magnesium, cadmium, zinc, etc.) pass into the gaseous state, bypassing the liquid phase. This process is called sublimation. The main elements of the vacuum deposition installation and its simplified scheme are shown in Figure 1.

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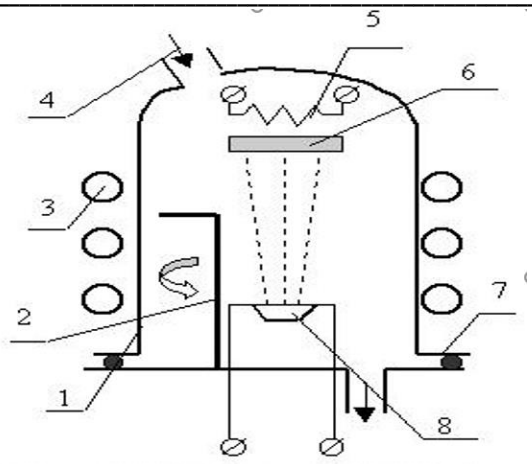

Figure 1 - Simplified diagram of the working chamber of the thermal vacuum deposition unit.
1 - stainless steel vacuum cap; 2 - damper;
3 - pipeline for water heating or cooling of the cap;
4 - needle leak for supplying atmospheric air into the chamber;
5 - substrate heater; 6 - substrate holder with a substrate on which a stencil can be placed; 7 - sealing gasket made of vacuum rubber; 8 - evaporator with a substance placed in it and a heater (resistive or electron beam)

Obtaining Films By The Vacuum Method: Vacuum post VUP-4, located in the laboratory of "Materials Science", as mentioned above, allows you to create the vacuum necessary for deposition of thin films of various materials. This vacuum post has not been used for a long time. In this regard, there was a natural aging of its mechanisms and parts.

Checking the ability of the vacuum station VUP-4 to deposition thin films: We have carried out test experiments on the deposition of thin films on various materials. Glass was chosen as the first substrate, onto which an attempt was made to deposit copper. The result is shown in Figure 2.1.

Figure 2.1 - Sputtered layer of copper on a glass substrate

We got quite good results. The sprayed layer turned out to be uniform, without visible flaws, with a smooth mirror surface. [2] [3]

The scan results are shown in Figure 2.2, at 2 different magnifications.

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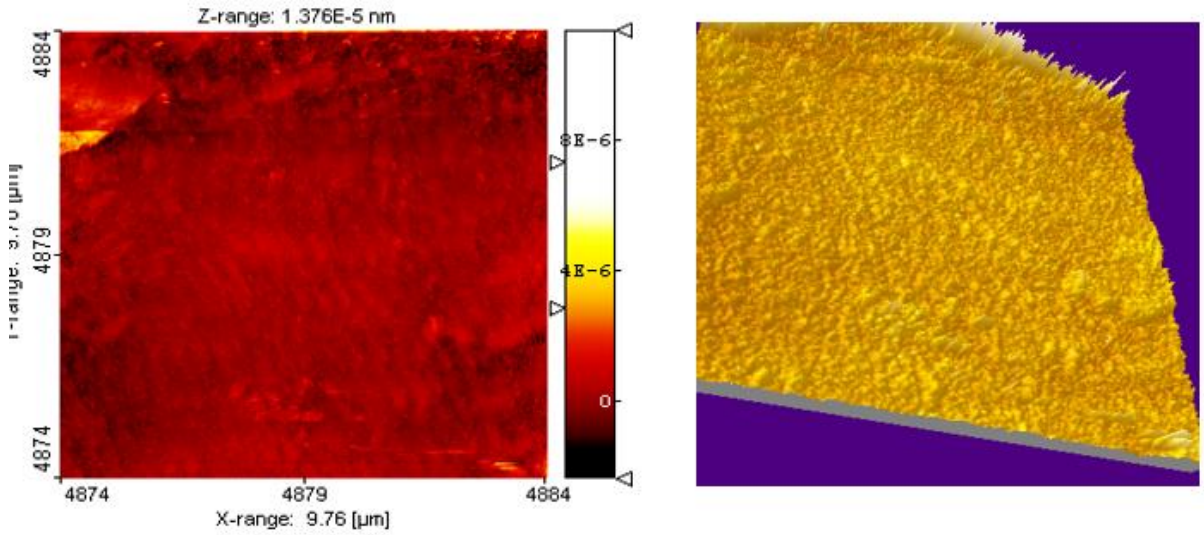

Figure 2.2 - Surface relief of the deposited copper film obtained using a tunneling scanning microscope at various magnifications

As can be seen from the obtained images, the sputtered copper surface has a good structure, very small irregularities, not exceeding nanometers.

Thus, we have achieved a high quality of spraying.

The next experiment was deposition of graphite on glass and ceramic substrates, the result of deposition is shown in Figure 2.3.

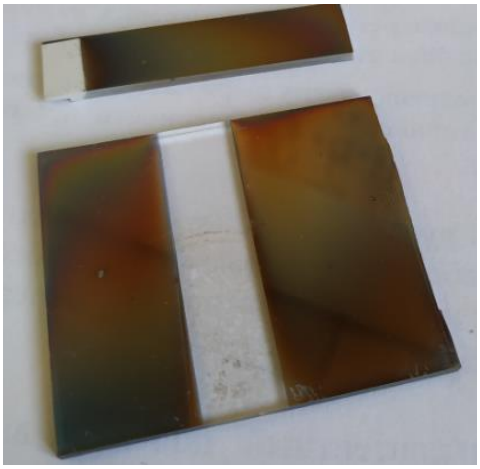

Figure 2.3 - Sputtered graphite layer on ceramic (top) and glass (bottom) substrates

As in the case of copper, the deposited layer was of high quality with a smooth, uniform surface.

Thus, it can be argued that the VUP-4 vacuum station allows the deposition of films of various materials on various high-quality substrates. [4] [5]

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