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Research and development complex with remote access

Y V Panfilov, L L Kolesnik, V T Ryabov and S V Sidorova

Department of Electronic technologies in mechanical engineering, Bauman Moscow State Technical University, “BMSTU”, 105005 Moscow, Russia

E-mail: panfilov@bmstu.ru, sidorova@bmstu.ru

Abstract. Vacuum modular tool for thin films vacuum deposition was considered. Deposition tool automatic control system built-in to the remote access. Methodological support for the preparation of laboratory works and virtual simulator for mastering the ability to work on the vacuum deposition tool were developed.

1. Introduction

In the framework of the State contract were designed vacuum modular deposition tool for deposition of thin films modular automatic control system, technical support for the preparation for laboratory works performance, system of remote access to the installation and a virtual simulator performing the training role for mastering the skills [1].

However, the wide distribution in the educational process of other universities, developed an interactive educational-scientific complex have not received. That for several reasons are: the absence of industry regulations for its use, the need for additional funding works to improve the property and introduce it into the educational process and limited options for laboratory work because of the use of while only one method of applying thin films of resistive thermal evaporation.

2. Vacuum modular deposition tool

Vacuum modular deposition tool “UVN-1M” (figure 1(a)) is a part of research and development (RND) complex and equipped with oil-free pumping system [2], a vacuum chamber with a volume of 2 l, quick-detachable flanges, one of which is a resistive evaporator, and another substrate holder with a dielectric substrate (figure 1(b)). Formed on the substrate contact pads to which through a sealing current lead is connected measuring device: picoammeter, LCR-station or other device that measures one of the characteristics of a thin film [3]. The automatic control system connected to the local network with access to the Internet. External view of the vacuum modular deposition tool shown in figure 1.

This configuration allows measurement of key characteristics of coating films during their formation. As an example, in figure 2 shows a graph of the current flowing between the pads depending on the time of the first island formation and then a continuous film [4].

In the second portion of the graph the non-linear dependence in the current increase indicates the thin film discontinuous (islet) growth with the coalescence of islands and the change of the distance between them. On this site it is possible to study the initial stages of thin films growth depending on the deposited material, deposition rate and energy of film-forming particles, which depends on the application a thin film method.



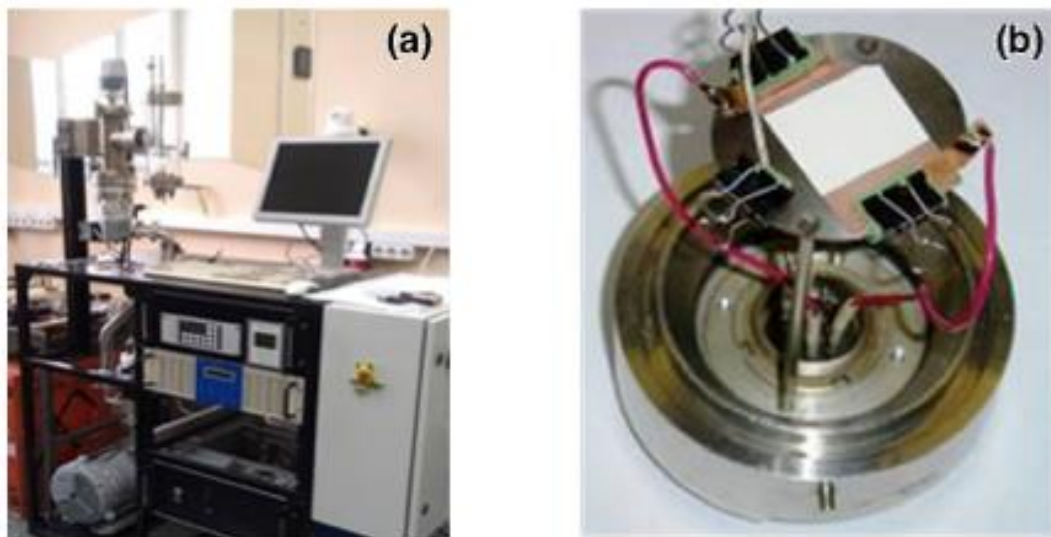


Figure 1. External view of the vacuum modular deposition tool “UVN-1M” (a) and the upper flange with the substrate based on the substrate holder (b).

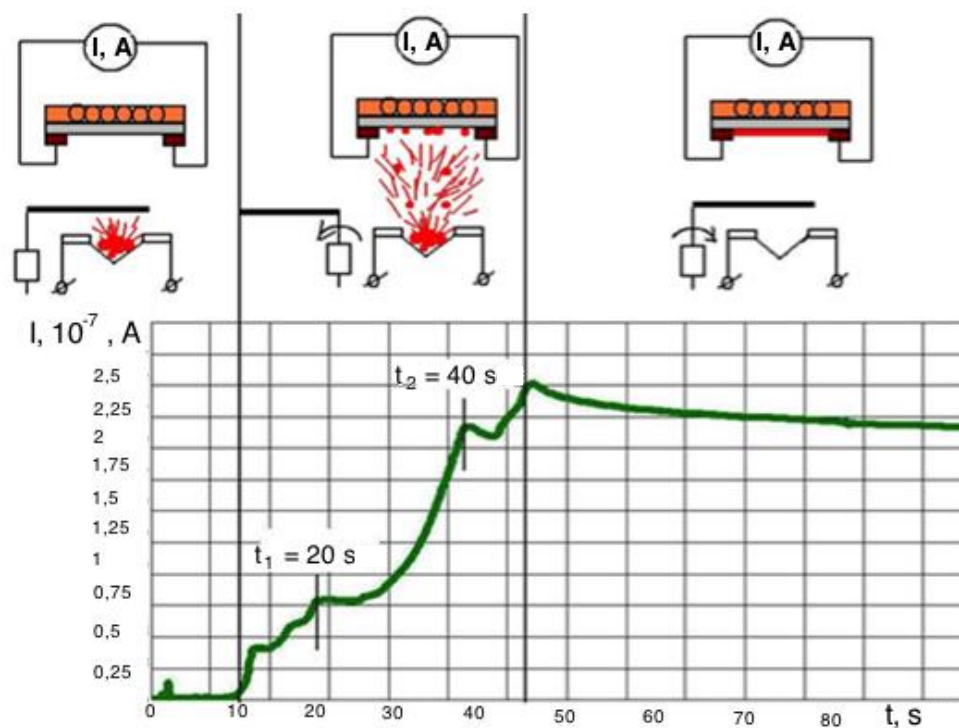


Figure 2. Current flowing between the pads depending on the thin film formation stage

The laboratory work methodology includes the theoretical foundations study of the thin films technology and mastering the ability to control the deposition tool using the built-in simulator. Passing the test and getting admission to the laboratory work, students in the computer class, to commence laboratory work in remote access mode.

3. Remote access system

A special program – remote access server – to provide remote access to equipment has developed [5]. General scheme for the remote access to the equipment is presented in figure 3.

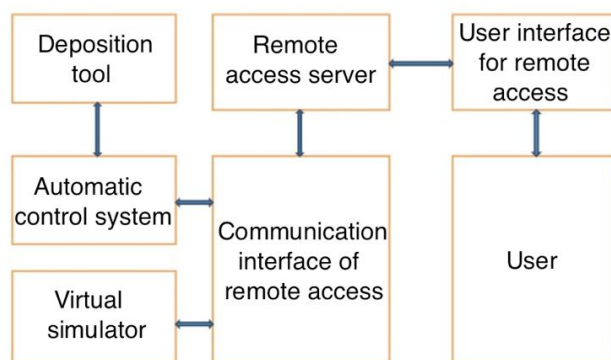


Figure 3. General scheme of remote access organization to equipment.

The vacuum tool automatic control system is connected via the driver pairing to the system for remote access. The driver pairing is an intermediate link between the equipment and the remote access server. It has a clear specification of the controlled format descriptions and control signals, through which it interacts with the system. Implementation of interaction with the real automatic control system is hidden inside the driver. This solution allows you to connect virtually any process equipment equipped with a control system by writing to it the driver corresponding to the specifications of the remote access systems without changing the functionality of the software part of the complex.

As a real vacuum deposition tool can be a virtual simulator equipment, which also connects via the same driver. A virtual simulator allows you to fully simulate a job, giving the user the feeling that he is working with real equipment. This option requires the presence of an operator, allows you to simultaneously conduct multiple virtual experiments and can be used for training purposes.

When working with equipment in the remote access mode in real time and in virtual simulator implemented techniques and algorithms with the transactions exception that require manual action on the equipment side, for example, the installation of the substrate. For such operations the simulator just gives a signal about readiness of the equipment to work.

You can connect the required number of virtual simulators or facilities to the remote access server. Their number is determined by the power computing means and the data channel. The remote access server on the one hand communicates with the hardware through drivers pairing, and on the other hand accepts client connections from the external network.

In this project adopted the concept of a two-tiered approach to creating a system of collective access to the laboratory resources. The first level access is the equipment access the virtual laboratory through a local network, the second – via the Internet.

Educational-scientific complex can operate in three modes: in the mode of directive management, remote access in real time and in virtual simulation. When working in the mode of directive control, the user is immediately around the vacuum tool of independently producing all of actions. In this case, the algorithm and methodology for end-user interactions with the educational-scientific complex is no different from working with any other technological equipment.

In the remote access mode in real time, the user controls the installation via a LAN or the Internet. In this case around the installation requires the operator to perform manual operations. In case of emergencies or loss of communication with the user, the operator can translate the installation to the legislative management regime.

If the mode user directive control (if it necessary) has the opportunity to conduct a technological process, using the controls located directly on the power supply, the remote control all the actions happen only through a personal computer with installed software. Any command received remotely, is processed in the control system, checks for the correctness of the action and passed to the appropriate subsystem installation.

In the virtual simulator, as mentioned earlier, the user interacts with the simulator installation. The presence of the operator is not required. You can connect to conduct virtual experiment for multiple users. Accept connections when working in remote access mode without using a web server, connecting directly to the remote access server. To connect, you need to use a special program – a thin client.

This connectivity option allows you to reduce the server response time and provides process control equipment closest to the real control mode.

Software product interacts with the user, implements the concept of thin client. To work with complex sufficient to have only the special client software.

4. Conclusions

The developed method is suitable to almost all methods of thin films vacuum deposition such as electron beam evaporation, magnetron sputtering, molecular beam epitaxy, atomic layer deposition etc. It can be implemented in any laboratory vacuum tool for thin film deposition with automatic control system.

For example, there are small vacuum systems series developed in JSC NIITM (Zelenograd, Moscow, Russia), which could be included for training of thin film deposition in vacuum according to the manufacturer intended (figure 4) [6].

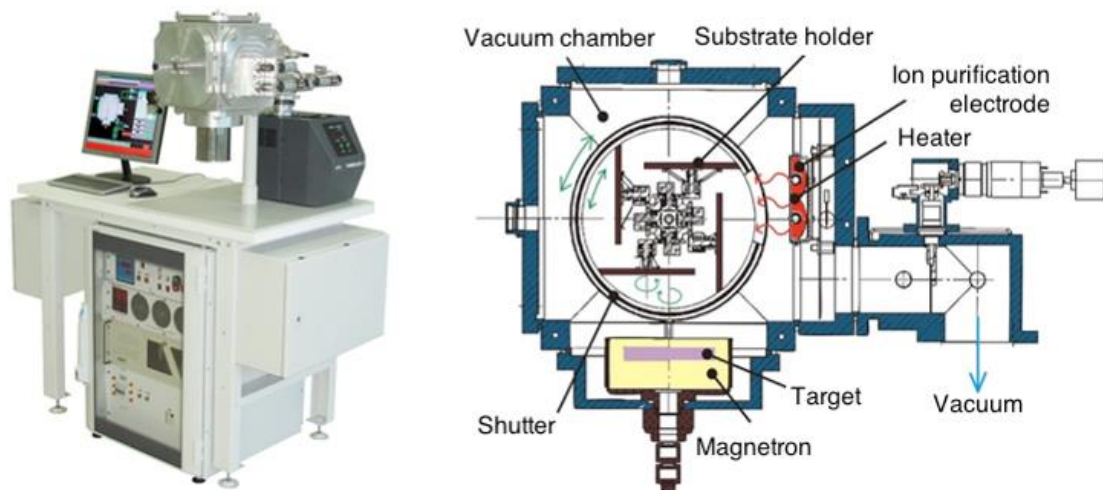


Figure 4. Vacuum tool for thin films vacuum deposition (“MVU TM”, JSC NIITM).

It can be noted that these tools are not equipped with training manuals for practical classes with students, which makes such implementation complicated. Equipment settings system remote access with a virtual simulator and supplying in conjunction with the teaching materials can significantly expand the circle of potential consumers.

References

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