THE CREATION OF STRUCTURED FILMS Al_2O_3

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Introduction. In recent times the works aimed at the creation of nanoscale arrays of memory elements are of great interest. As a rule nanoparticles of magnetic composite are precipitated via electrochemical method on the flat surface of substrate. If the array on substrate presents the ordered structure with noninteracting nanoparticles then each particle can act as a simple bit of information.

Self-organized nanostructures are formed during the anodization process in solution of sulphuric acid on the surface of aluminium, representing the array of nanoscale pores [1]. Besides, it can become possible to achieve very important practical properties such as controlled pore diameter (50–500 nm), high isolation of pores, as well as the regularity and uniformity of the resulting structures. In addition, obtained by the anodization oxide film has such protective properties as high corrosion resistance, strength and hardness.

The purpose of the work. The aim of the work was to identify the optimal parameters of creation of Al_2O_3 oxide pores structured array on the surface of various samples of aluminum by chemical electrolysis (anodization) for the further use of this structure as the basis of magnetic nanocomposites.

The basic positions of the studies. The structure of the oxide is a set of hexagonal cells with a pore in the central parts. On the geometric parameters of the cells and pores has the greatest impact following parameters: the composition of the electrolyte, electric modes of formation, temperature, time and the structure of bath [2]. The following regularities were revealed: the thickness of the resulting layer is directly proportional to the reaction time and skipped current, the number of received pores is inversely proportional to the supplied voltage, the decrease of temperature leads to the increase of ordering of pores, the distance between centers of neighboring pores depends on the composition of electrolyte.

Used as electrolyte the 20% sulfuric acid solution poured in a glass bowl, lead cathode, power supply unit with DC, the device for mixing electrolyte for uniform distribution of solution density and temperature, cooling system and samples of aluminum were used in all experiments.

Results and discussion. The samples with thin (500 nm) films of aluminum were proved to be the most acceptable ones for the creation of ordered pores. With respect for the recommended settings on the surface of aluminium the porous structure grew. The pore diameter was about 120–150 nm, the depth was from 9 to 12 nm.

On the samples of aluminum plates quite deep pores (15–20 nm) with the diameter about 60 nm were received. However, these pores did not have a hexagonal shape and fused in local areas of the surface.

When using the samples of aluminium granules the porous layer was obtained only as a result of a two-stage anodizing process according to the scheme «victim layer – porous layer». The obtained structures had low regularity and were from 400 nm to 600 nm in diameter with the depth only about 4–12 nm. The size of the non-periodic formations on the oxide of granules of duraluminium was about 250 nm in diameter and about 120 nm in depth.

A significant impact on the results was provided by: the decrease of temperature of reaction, the existence of systems of electrolyte circulation for uniform distribution products of reaction,

the samples preparation, selection and subsequent monitoring parameters of current, voltage and time of the reaction. It should be noted that the degree of roughness of the substance has a special impact on the received structure, as divergent growth of the aluminium oxide takes place on the large defects of the surface.

Conclusion. In this paper the works on the preparation of various samples to anodization with the detection of optimal parameters for obtaining thin oxide films with ordered pores of Al_2O_3 were performed. The main parameters influencing the process of aluminum oxidation were examined and the recommendations to the conduction of these experiments were given. It is found that the best ordering of pores and their parameters arise under anodization on thin (500 nm) films of aluminum. It is necessary to use substrates for spraying with good adhesion to aluminium.

References

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INTEGRATION OF OPEN SOURCE TECHNOLOGIES IN HIGH SCHOOL MECHATRONICS

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This article describes advantages of using open-source technologies in keeping educational process up-to-date. It contains an example of educational course, which was designed to be implemented on the 1-year students of Mechatronic department of NRU ITMO. This course is based around Arduino open-source hardware. Using cheap and up-to-date technical solutions motivates students to go deeper in their specialty and create projects at home. Great amount of different articles, projects and approaches generated by worldwide community helps students to find way of learning more suitable for them. Explaining the basics and helping with advice becomes the primary task of the tutor. Rapid development of open-source technologies and their low price makes educational process more flexible and allows integration of new solutions right on the way. Open-source license gives no restrictions in selling devices based on the technology explained during course, this gives students an opportunity to earn money selling their project works, while proprietary educational kits forbid using their equipment for commercial purposes.

It is common knowledge that mechatronics is a rapidly developing field of engineering. This fact makes it critical to teach students using up-to-date and powerful hardware. Educational courses are usually lagging behind life and when we talk about rapidly developing field of science, this backwardness can be fatal. And, as we are talking about applicable science, no one is interested in producing specialists, who are well trained to work with outdated technical solutions. So nowadays the main goal of mechatronic methodologist is not only to create an up-to-date educational course, but to develop a positive approach, which will make educational program more flexible and, as a result, actual.

Open-source solutions can lend a helping hand in this situation. They have several advantages over proprietary educational kits. They are cheaper, they have larger support communities, their

licensing makes it possible to create end-user product and modify them, when it is necessary.

An experimental group was formed in an attempt to create such educational course for 1-year students. It consists only of volunteers, who are willing to discover something new and create their projects far from narrow frames of specially designed kits. Arduino was selected as the core of the new mechatronic course. It has all the benefits, described above, but of course there are some limitations, which are not critical for the beginner course. Microcontroller is programmed using Arduino IDE – open source integrated development environment. Schemes and circuits are drawn using open source Fritzing editor.

Arduino microcontrollers are basically programmed with Arduino programming language, which is nothing more than Processing/Wiring – a C++ dialect. So the programming skills, gained during the course won't be useless later, on a higher levels.

As the skills of different students are different, some of the learners experience problems even with the principles of non-soldering breadboard. Fritzing editor is really helpful here, as it can transform the visual appearance of the breadboard into principal electric scheme. This feature gives an opportunity for students, who are not familiar with principal schemes to catch up with their more skilled colleagues. This makes it possible to make educational process clear for students of all skill levels.

Each lesson students discuss different problems which occur on their way, while they are developing their own ideas. Each lesson some small devices are created, which help students to gain experience in designing circuits and understand new syntax constructions. Each theoretical piece of information is imprinted in their memory by applying it on practice. By the end of each lesson a number of new questions is accumulated, these questions will be the topic of the next lesson. All these questions, sketches and schemes are recorded and will be transformed into a workbook by the end of the experiment. Also list of necessary equipment is being created.

For example, during creating a large LED array, students faced problem of limited number of outputs. They were immediately introduced to shifters. While the principles of the shifter were explained, students also found out some information about electronic device packages, their differences, mounting and purposes. According to this information, they were able to choose the exact shifter that was needed, work with it's specification and write a program, using examples from community web-sites.

Also, while developing mechatronic projects, we shouldn't forget about GUI. At the moment GUI is written using Visual Basic, but due to platform limitations it will be replaced either by Python, or by Qt.

Students like this approach and show good results. They are motivated to browse community resources on their own and pick new ideas there. If they find something difficult to understand, they ask the tutor and receive qualified explanation. All these questions are also recorded in order to form theoretical part of the course.

By this time project is practically done. Current situation makes the future of the project look optimistic. The course will be tested next year. If it will work out the expected way, we will have a good introductory course designed for students by students, which will include all necessary equipment, theoretical and practical parts inseparably connected together. Moreover, we will have an approach, which will make us able to create courses for higher levels.