

## Probe microscopy for investigation of conical nanowires

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A large number of studies have been devoted to the preparation of metallic nanowires (NWs) by the matrix synthesis method. It is known that, in addition to the “traditional” cylindrical NWs, the method makes it possible to obtain cone-shaped nanostructures. Such structures are interesting in that their top has a small radius of curvature and can be used for the emission of electrons or ions. Currently, such nanowires with a variable cross section are also of interest as candidate materials for spintronics.

To obtain such structures by matrix synthesis, it is necessary to fabricate a matrix with conical pores and to obtain replicas of these pores. The first problem is solved by etching the pore channels in the irradiated polymer film in an alcohol-alkaline solution. Obtaining conical replicas consists in applying a thin metal contact layer (thermal sputtering of copper in a vacuum), followed by filling of dead-end pores with the required metal; both processes are carried out on one side of the membrane.

The method of probe microscopy was used in the work at two stages – to study the polymer matrix and to study the resulting conical structures. The AFM image of pores in TM allows not only to estimate the size of pores, but also to estimate the degree of inclination of the pore walls. After galvanic deposition, the resulting conical replicas were also studied by the AFM method. Figure presents the image of the topography of a single cone.

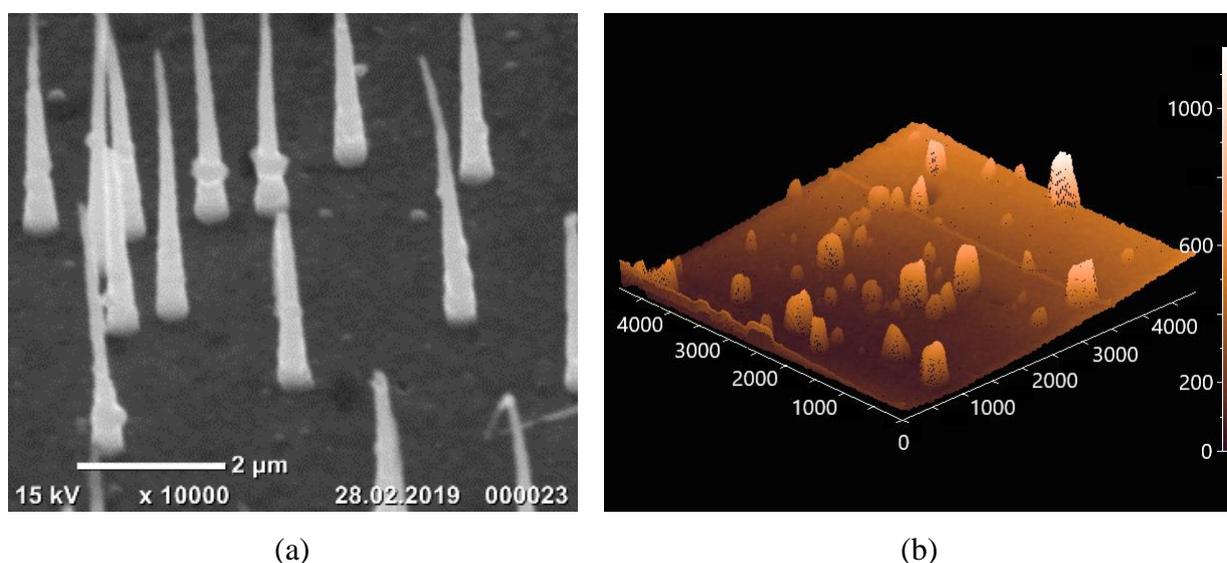


Figure 1. (a) SEM and (b) SPM-image of conical nanowires.

The resulting images demonstrate the correlation of SEM and AFM images. In addition, they allow a detailed assessment of the topography of the tip. Thus, the shape of the tips – different from the cone – suggested that the electrolyte does not completely fill the “bottom” of the conical pore during the electroplating process. To overcome this negative effect, several types of additives have been used. It was shown that the use of the “brightener” gave the best effect.