View of the bacterial strains of Escherichia coli M-17 and its interaction with the nanoparticles of zinc oxide by means of atomic force microscopy

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Abstract. Visualization of the structure of biological objects plays a key role in medicine, biotechnology, nanotechnology and IT-technology. Atomic force microscopy (AFM) is a promising method of studying of objects' morphology and structure. In this work, AFM was used to determine the size and shape of the bacterial strains of Escherichia coli M-17 and visualization its interaction with the nanoparticles of zinc oxide. The suspension of E.coli bacteria was applied to natural mica and studied by contact mode using the FemtoScan multifunctional scanning probe microscope.

1. Introduction

Bacteria are among the simplest structures of living organisms. It is believed that they are the first organisms that appeared on Earth. In extreme conditions, unsuitable for the existence of other organisms, bacteria can be the only form of life. In this regard, the study of bacteria is of great interest. A promising area of application of the bacteria is the IT-technology. Using the bacteria as a storage device is not a new idea: it was proposed by a group of Bancroft in 2001, and a team of scientists involved in Yachi information storage in the genome of the bacteria since 2007. Bacteria provide secure storage of information. Since it multiplies and makes additional copies of the data. Some microorganisms can survive the radiation of a nuclear explosion preserving while the recorded data. One species of bacterium E.coli can save only one kilobyte of information. One gram bacterium E.coli produces the number of individuals of this species equal to the total amount of information 931322 GB (450 hard disk memory to 2 TB). Bacterial cells have an ability to change the genome in the process of adaptation to changing external conditions. Due to high speed of division and possible changes in genome they can withstand antibiotics, chemical agents, nanoparticles with functional properties. Here we study the morphology of Escherichia coli M-17 bacteria and their interaction with zinc oxide nanoparticles.

2. AFM of the bacterial strains of *Escherichia coli M-17*

This work demonstrates the application of AFM to the study of bacteria. AFM uses a cantilever that measures the force of van der Waals interactions, or electrostatic attraction, repulsion forces. It's a fine needle fixed vertically on the elastic console. The method helps to measure the attraction or repulsion of the atoms in the sample and the atoms in the cantilever. The laser beam is directed at the reflective surface of the free end of the console, while the tip is placed on the opposite side of the console. The beam is reflected by the surface of console and then is directed to the photodiode. Depending on the changes of the cantilever-surface interaction force the cantilever console bending occurs and the laser beam is deflected from the central position on the photodiode. The feedback system changes the

position of the sample, so that the reflected laser beam returns it to the "zero" central position on the photodiode. Thus, by registering the sample shift required to return the laser beam to the "zero" point the system measures a surface topography. FemtoScan scanning probe microscope was used in the experiments. Images were processed using FemtoScan Online software [3].

Figure 1,2 shows images of bacteria. Bacteria have oval flattened shape. The size of bacteria is of 1 to 2 micron.

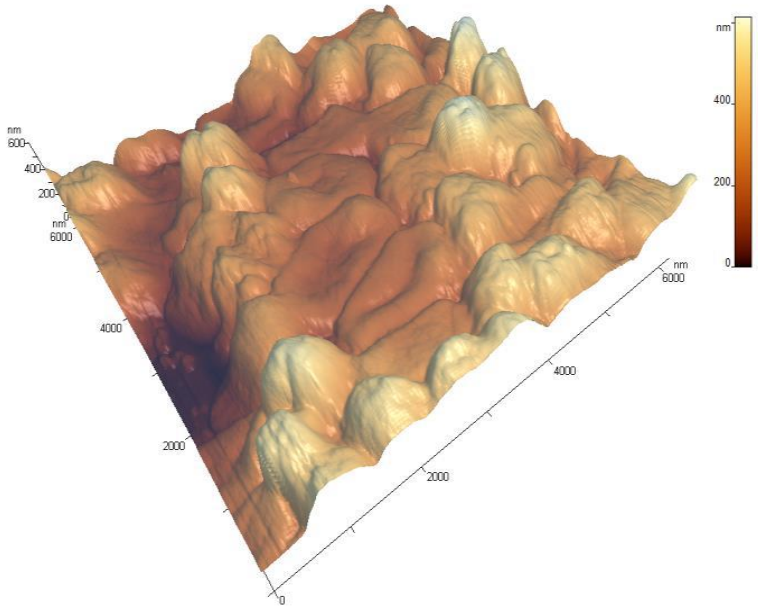

Figure 1. AFM 3D image of strains of Escherichia coli M-17.

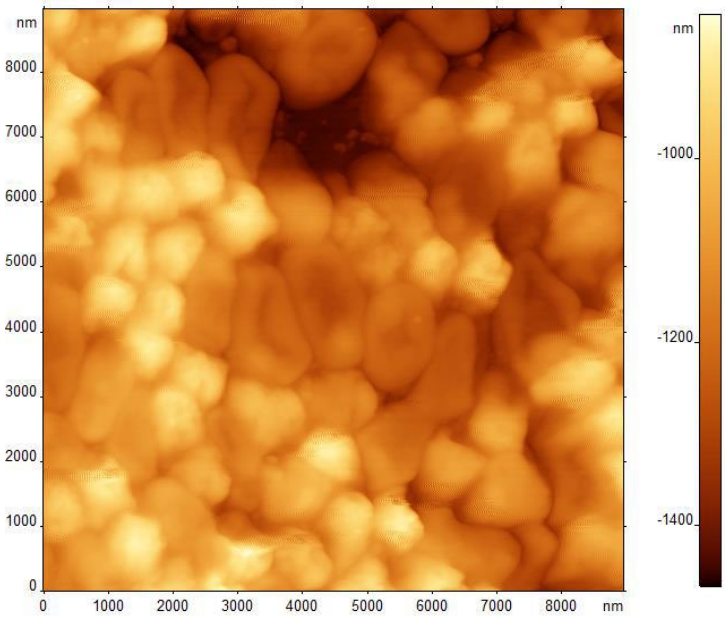

Figure 2. AFM top image of strains of Escherichia coli M-17.

3. Zinc oxide nanoparticles

Liquid colloidal solutions of metals and metal oxides were obtained using a condensing-disperazione electropulse installation, in the low-temperature plasma area. Synthesized nanoparticles of zinc oxide have a high zeta potential, greater than 20 mV by absolute value. This indicates on some kinetic stability of colloidal solutions. The presence of negative surface charge on the diffusion mobility boundary of zinc oxide nanoparticles, is caused by the concentrating of negatively charged particles on the surface of the solid phase particles. By adding quaternary ammonium compounds in a zinc oxide colloidal solution the adsorption of cation surfactant takes place on the surface of the nanoparticles.

4. The interaction of bacteria with nanoparticles of zinc oxide

Figure 3, 4 shows images of the bacterial strains of Escherichia coli M-17 after adding nanoparticles of zinc oxide. Bacteria form agglomerates and retain their shape.

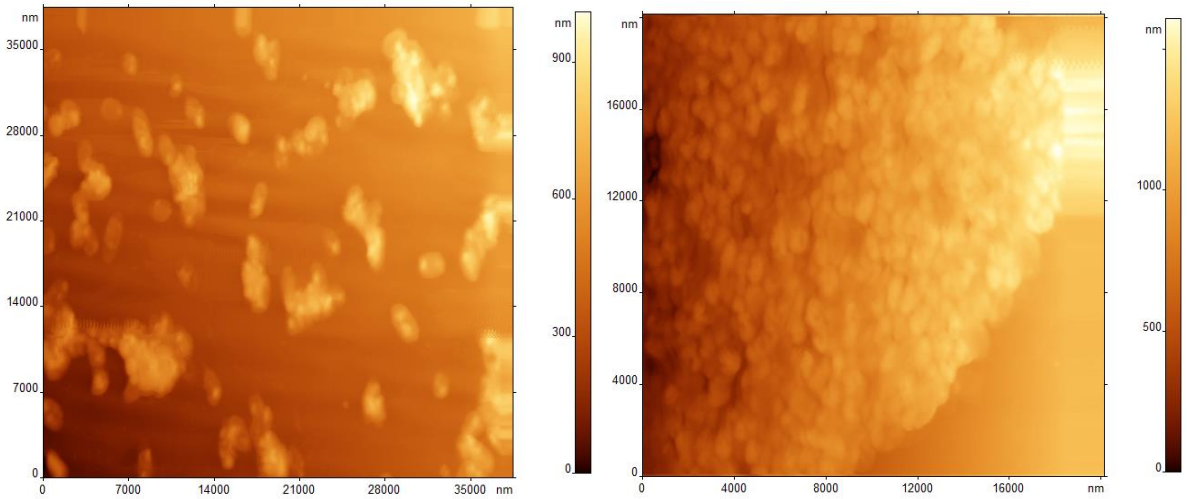

Figure 3 (a,b). AFM top image of strains of Escherichia coli M-17 with nanoparticles.

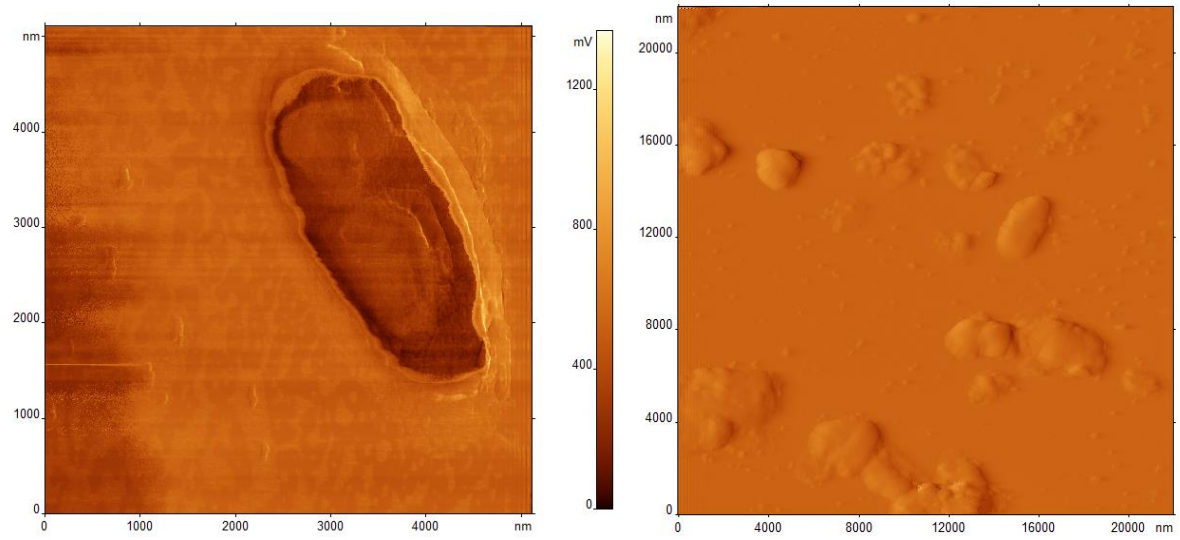

Figure 4 (a,b). AFM top image of strains of Escherichia coli M-17 with nanoparticles, friction mode (left image) and deflection mode (right image).

During our preliminary observations we did not see the visible changes of the morphology of individual cells (fig 4a). Still there are seen some difference in bacteria aggregation (fig 3). The bacteria in the presence of Zinc oxide nanoparticles do not produce dense films of closely packed bacterial cells as it is seen in the fig 1 and 2 for the samples with no addition of nanoparticles. Probably the intercellular interaction is affected by Zinc oxide nanoparticles.

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