UDC 539.2

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Investigation of metallized hydrophilic polymer films Using atomic force microscopy

Abstract

The morphology and properties of metallized hydrophilic polymer are investigated on an atomic force microscope Ntegra Therma (the company "NT-MDT", Zelenograd, Russia). The atomic force microscopy is one of the foremost tools for imaging, measuring, and manipulating matter at the nanoscale. The information is gathered by "feeling" the surface with a mechanical probe. A special technique of atomic force microscopy was picked for qualitative analysis of samples based on polymeric materials. It was shown that the introduction of small amounts of PANI (0.01-0.02 wt.%) results in the data of atomic force microscopy which show that in the presence of an electrically conductive polymer structure the system changes significantly. Comparing the metallized with silver different polymer systems, the quality of the surface metallization of PI + PANI is higher than the surface of the polymer system PI-PU: the silver particles are uniformly distributed on the surface of the PI + PANI and the average particle size of silver from 75 to 150 nm.

Key words: Atomic force microscope Ntegra Therma, probe, polymeric systems, inhomogeneous structure, surface metallization.

Introduction

There are many difficulties associated with the research of structure of polymeric materials, in this connection there is a necessity in the choice of research methods. In particular, the morphology of the films can be used in atomic force microscopy (AFM), for which in recent years entrenched its status as one of the main methods for studying surfaces of solids [1,2]. Its main advantage over other types of microscopy (optical, electron) is that it provides a three-dimensional image [3]. Although this method is used to study the extremely broad class of objects (macromolecules, biological objects, nanostructures), difficulties arise in the study of polymers and powder samples.

For qualitative analysis of samples based on polymeric materials is necessary to choose a special method for scanning probe microscope. One of the most common types of scanning probe microscopy is an atomic force microscopy. In scanning probe microscopes study surface microstructure and its local properties is carried out using a specially prepared probe in the form of needles. The working part of these probes has a size of about ten nanometers. The typical distance between the probe and the sample surface to probe microscopes in order of magnitude is 0.1-10 nm.

Main part

This work investigated the morphology and properties of metallized hydrophilic polymer on an atomic force microscope Ntegra Therma (the company "NT-MDT", Zelenograd, Russia). For qualitative analysis of samples based on polymeric materials was necessary to pick a special technique of AFM.

According to atomic force microscopy can be seen to change the structure of polymer films, with the stage of metallization with silver (Figure 1).

Comparing the metallized with silver different polymer systems, we can conclude that the quality of the surface metallization of PI + PANI is higher than the surface of the polymer system PI-PU: the silver particles are uniformly distributed on the surface of the PI + PANI and the average particle size of silver from 75 to 150 nm. In the study of the surface of the PI + PU + PANI showed that compared with the systems of the PI and PI + PU + PANI, the silver particles sit evenly and does not seem of minor defects that were noted in the morphology of the previous polymer systems.

These phenomena can be explained by the fact that the metallized polyurethane film researched very little, the result is a metal layer of the inhomogeneous structure [4]. Improving the ability to metallization occurs when introduced into a system of conductive polymer-polyaniline (PANI), and in preparing the compositions PI + PU + PANI plating is better compared to the original preparation of polymeric systems.

Research was also conducted on the choice of metals, chemical vapor deposition on a polymer surface which is uniform with the formation of uniform-density structures. Using atomic force microscopy revealed that the best polymer system PI + PU + PANI metallized with silver (Figure 2). Thus, in this research have been studied especially modified polyimide based on dianhydride

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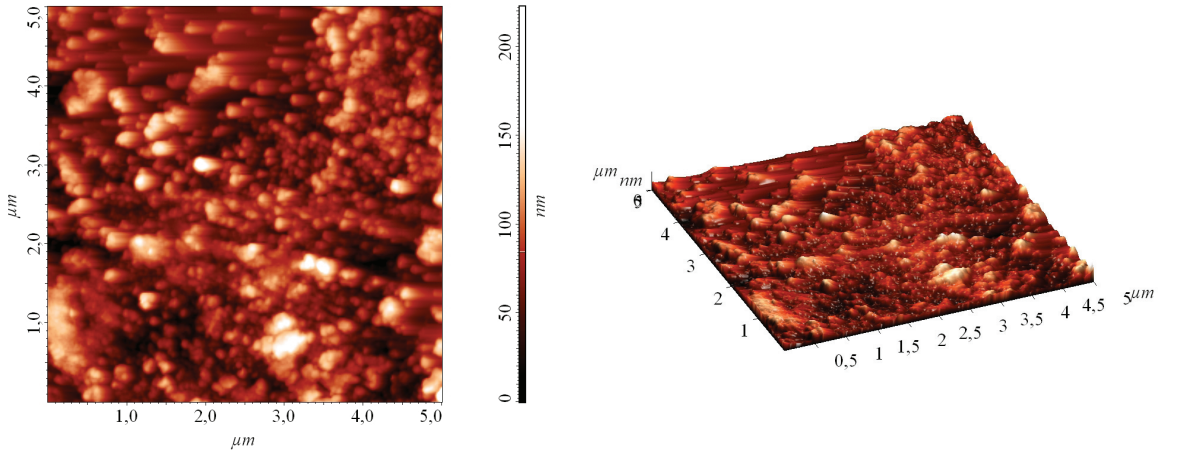
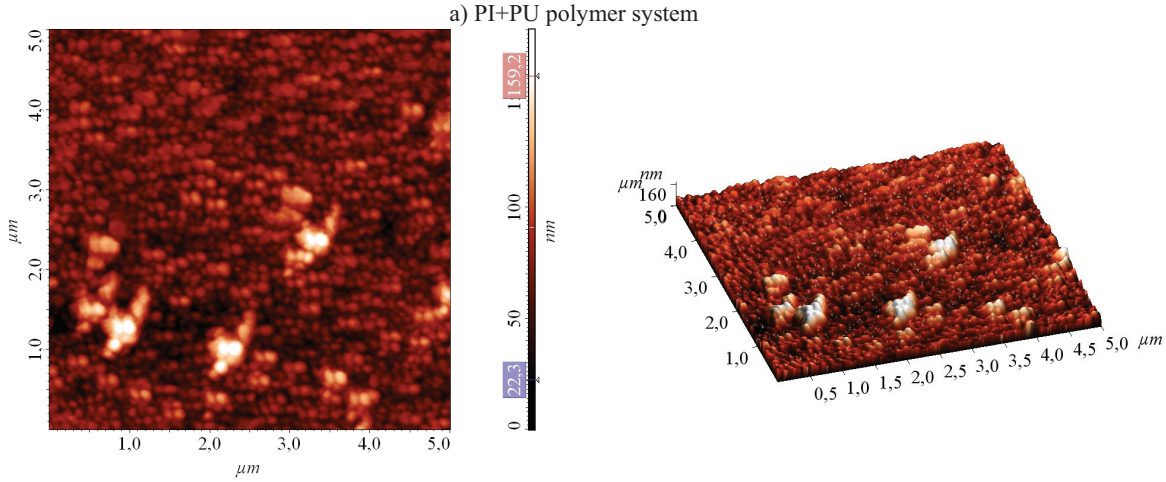
 Printed in Kazakhstan

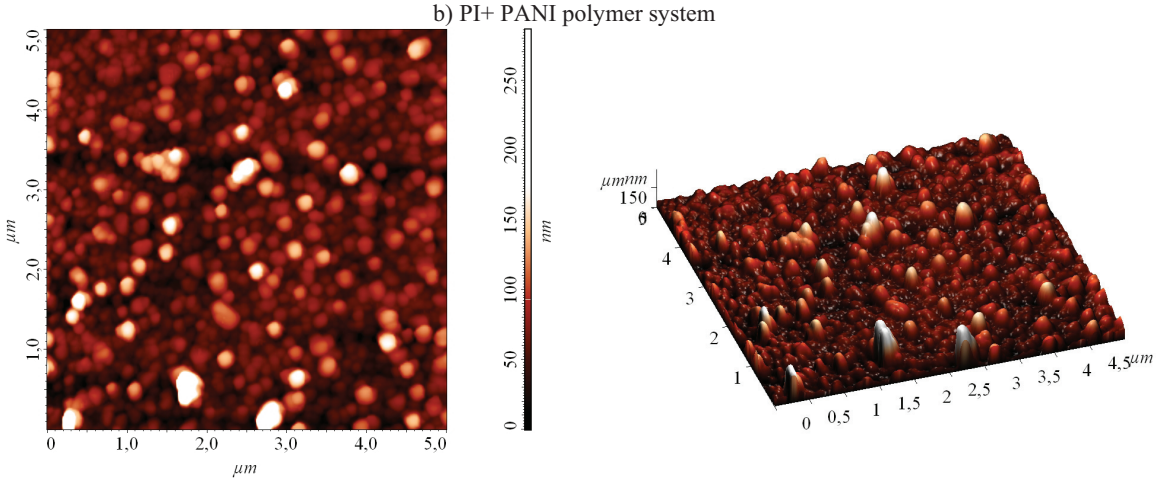
threecyclodecinthetracarbon acid with an aromatic diamine polyurethane based on 4,4 '-methylene-bis-(phenyl isocyanate) and the oligomer and The Lady. Shows the good compatibility of polyimide with polyurethane to a concentration of 2.0 wt. % of the latter. It is shown that the introduction of small amounts of PANI (0.01-0.02 wt.%) results in The data of atomic force microscopy show that in the presence of an electrically conductive polymer structure of the system changes significantly: clusters of silver produced large compared to the metal particles in the unmodified polyimide. In the absence of polyaniline film metallization of polyimide compositions + polyurethane runs poorly, the amount of metal in the system is 1.5-2.0%.polymer composites with high-quality metallized ability, fine-grained homogeneous structure.



a) PI+PU polymer system



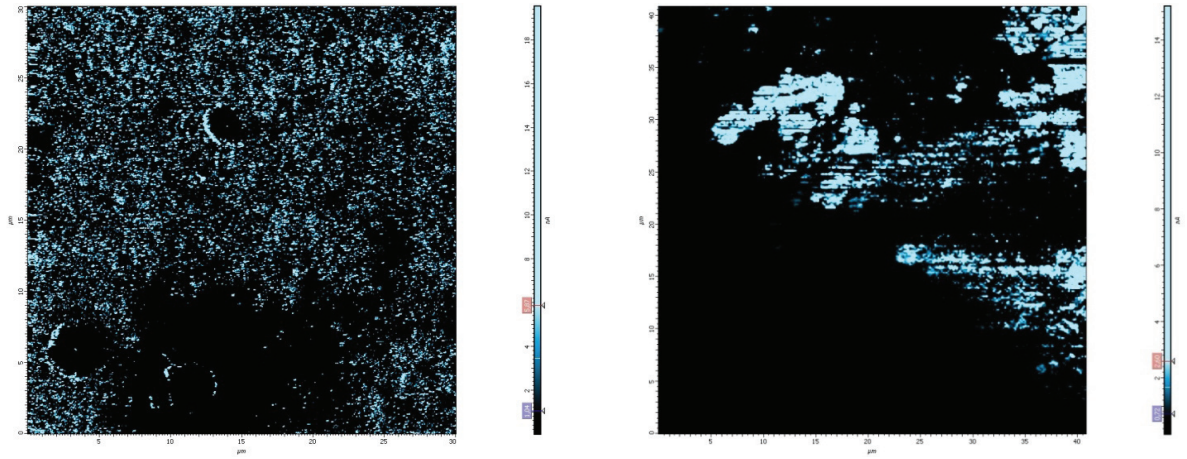
b) PI+ PANI polymer system



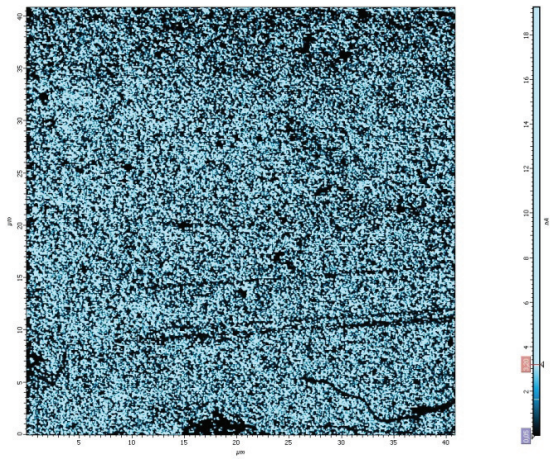
c) PI+PU+PANI polymer system

Figure 1 - AFM image of the composite polymer systems

New data on the microstructure of polyimides with varying degree of metallization, and their compositions with other high-molecular compound, polyurethane optical characteristics greatly expand the use of these materials, further reveal the unusual application of their use, such as microelectromechanical systems for optical barcode scanner for visually impaired eye.



a) Cobalt b) Copper



c) silver

Figure 2 - AFM image of a metallized polymer: the distribution of current spreading – the image signal Ipr low (size 40×40 mm)

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