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Atomic force microscopy of butadiene-nitrile rubber composites deformation

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Statement of the Problem: Rubber has an excellent sealing ability and can be successfully used as sealing elements of different systems. There are no fields of industry where the rubber is not used. But sometimes the use of rubber has limitations due to insufficient strength, resistance to wear and oil, etc. The application of the fillers into rubber mix is one of the usual ways to improve up of physical and mechanical properties of rubbers specifically hardness, tensile straight, modulus. The properties of filled rubbers strongly depend on the interaction between the filler particles and the polymer matrix. There is a close correlation between the structure of filler and the modulus of a rubber product compounded with that filler. But still the reinforcing mechanism of rubber with active fillers is not completely studied. The purpose of this study is to describe the mechanism of rubber reinforcement with the use of atomic force microscopy (AFM).

Methodology & Theoretical Orientation: AFM is perfect technique that allows us to see and measure surface structure with unprecedented resolution and accuracy. So, we employed AFM to study the surface properties of the supramolecular structure deformation of rubber composites under uniaxial stretching.

Findings: The influence of single-wall carbon nanotubes (SWCNT) on the properties of nitrile butadiene rubber (NBR). It was estimated that a small amount of SWCNT (less than 1 mass. part) into NBR does not lead to a change in the physical and mechanical and basic technical properties. A significant increase in strength characteristics is observed only at 2.5 and 5.0 mass. part of SWCNT. AFM allowed us to visualize of the deformation of the spatial grid structures formed by SWCNT, microcracks formation and to estimate the dependences of the Poisson's ratio and the surface roughness on the degree of uniaxial tension.

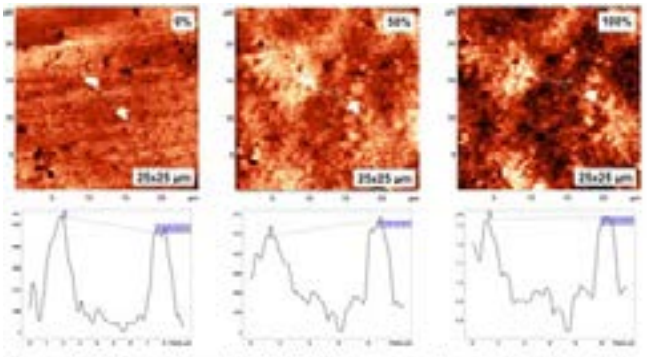

Figure 1: Deformation of NBR/SWCNT composite at uniaxial stretching

Recent Publications

1. Dorozhkin V.P., Muradyan V.E., Mokhnatkin A.M., Mukhtarov A.R., Mokhnatkina E.G. (2017) Single-wall carbon nanotubes in vulcanisates based on different rubbers: Investigation of the dynamic mechanical characteristics. International Polymer Science and Technology 44(6): 31-37.
2. Boonbumrung A., Pongdhorn S., Sirisinha C. (2016) Reinforcement of Multiwalled Carbon Nanotube in Nitrile Rubber: In Comparison with Carbon Black, Conductive Carbon Black, and Precipitated Silica. Journal of Nanomaterials. 1-8.
3. Sato Y., Hasegawa K., Motomiya K., Namura M., Ito N., Jeyadevan B., Tohji K. (2016) Reinforcement of rubber using radial single –walled carbon nanotube soot at its shock dampening properties. Carbon 46: 1509-1512.

4. Bagrov D.V., Yarysheva A.Y., Rukhlya E.G., Yarysheva L.M., Volynskii A.L., Bakeev N.F. (2014) Atomic force microscopic study of the structure of high-density polyethylene deformed in liquid medium by crazing mechanism. Journal of Microscopy. 253: 151–160.
5. Morozov I.A. (2016) Structural–Mechanical AFM Study of Surface Defects in Natural Rubber Vulcanizates. Macromolecules 49(16): 5985-5992.

Biography

Nikolay Shadrinov completed his undergraduate studies at North-Eastern Federal University, Russia in 2007, and earned his Ph.D. from Institute of oil and Gas Problems of the Siberian Branch of the Russian Academy of Sciences (IOGP SB RAS), Russia in 2012. Nikolay is a senior researcher in the materials sciences laboratory at the IOGP SB RAS. His research interests lie in the area of rubber composites development and structural researches, ranging from theory to design to implementation.

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