

Researchers use nanotechnology to improve the accuracy of measuring devices

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Scientists from National Research University Higher School of Economics and collaborators have synthesized multi-layered nanowires in order to study their magnetoresistance properties. Improving this effect will allow scientists to increase the accuracy of indicators of various measuring instruments such as compasses and radiation monitors. The results of the study have been published in a paper titled "Structure of Cu/Ni Nanowires Obtained by Matrix Synthesis."

One of the unique features of artificial nanostructures is the large magnetoresistance effect in thin layers of metal. This effect is exploited in various electronic devices.

The scientists synthesized multi-layered copper and nickel [nanowires](#) in order to study their characteristics, which depend on the layers' composition and geometry. "We expect that the transition to multi-layered nanowires will increase this magnetoresistance effect considerably. Today, we are choosing the method of nanowire synthesis in order to get this effect," said co-author Iliia Doludenko of the Moscow Institute of Electronics and Mathematics (MIEM HSE).

To determine the correlation between the synthesis parameters and the crystal structure, the scholars synthesized nanowires of different lengths. The nanowire length was determined by the number of deposition cycles; one nickel layer and one copper layer were deposited in each cycle. The size of the nanowires was determined using a scanning electron microscope (SEM). The number of pairs of layers in the nanowires was found to be 10, 20, or 50, according to the number of electrodeposition cycles.

When the length of the nanowire was compared to the number of layers, it turned out that the relationship between the nanowire length and the number of layers was nonlinear. The average lengths of the nanowires composed of 10, 20 and

50 pairs of layers were, respectively, 1.54 μm , 2.6 μm , and 4.75 μm . The synthesized nanowires all had a grain structure with crystallites of different sizes, from 5-20 nm to 100 nm. Large, bright reflections were mainly due to metals (Ni and Cu) while diffuse rings and small reflections are generally related to the presence of copper oxides.

An elemental analysis confirmed the presence of alternating Ni and Cu layers in all of the nanowires in the study. However, the mutual arrangement of layers may differ. Ni and Cu layers in the same nanowire may be oriented perpendicular to its axis or be at a particular angle. The individual units of the same nanowire may have different thicknesses. The thickness of individual units in nanowires is in the range of 50-400 nm.

According to the study authors, this heterogeneity depends on the parameters of the pore and decreases closer to the pore mouth. This leads to an increase in current, enhancement of deposition rate, and, as a result, an increase in the deposited [layer](#) thickness. Another possible reason is the difference in the diffusion mobilities of ions of different metals. This explains the nonlinear relationship between the nanowire length and the number layers mentioned above. The study of the composition of particular units demonstrated that copper units consist mainly of copper, while nickel is almost entirely absent. Nickel units, on the other hand, always contain a certain amount of copper. This amount may sometimes be as high as 20%.

The relevance of these findings relates to the potential creation of more accurate and cheaper detectors of motion, speed, position, current and other parameters. Such instruments could be used in the car industry, or to produce or improve medical devices and radiation monitors and electronic compasses.

More information: O. M. Zhigalina et al, Structure of Cu/Ni Nanowires Obtained by Matrix Synthesis,

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