Engineering solution for magnetic materials to significantly decrease costs of MRI research

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Project leader Yevgeny Gorelikov conducts laboratory tests of a magnet sample for an MRI scanner. Credit: The National University of Science and Technology MISIS

Researchers from the NUST MISIS Engineering Center for Industrial Technologies have developed an innovative technology for the production of magnetic materials and permanent magnets at a reduced cost. This engineering solution will allow scientists to produce affordable and efficient domestic magnetic resonance imaging (MRI) devices for wide use in public health clinics. According to the developers' estimates, it will reduce the cost of analysis with new MRI technology by half.

Magnetic resonance imaging is one of the most effective diagnostic methods in modern medicine. The diagnosis of cancer, multiple sclerosis, and musculoskeletal diseases in their early stages are all done with the help of MRI machines.

Due to its technical nature, an MRI machine can have ultraweak, weak, medium, strong, and superstrong magnetic fields. The highest quality pictures are taken by using superconducting magnetic systems generating very strong magnetic fields. However, MRI machines based on superconducting magnets provide the highest image resolution, although these machines are difficult to make and expensive to operate. That is why the procedures are generally inaccessible to most patients—it's simply too expensive for the clinic or hospital to use the machine.

When considering the savings gained from using the new MRI machines, most small clinics and private-practice doctors will prefer these cheaper, low-field MRI machines, which cover the overwhelming majority of most common diagnostic tests. Large hospitals, especially those interested in local spectroscopy and research in the field of functional tomography, will retain their interest in machines with stronger magnetic fields, but they will also buy scanners with weak and medium-sized fields as second and third installations for mass screening.

NUST MISIS scientists have developed a prototype of an economically and environmentally friendly low-field magnetic resonance imaging

prototype based on magnetic materials and components produced in Russia.

"We have developed an innovative technology for the production of low cost hard-magnetic materials and permanent magnets manufactured from alloys of rare, domestic earth metals and their compounds, including the ones obtained in the processing of industrial waste magnetic production. During the production of raw materials for permanent magnets we have managed to reduce their cost by 1.5 times through the use of industrial waste magnetic production and cheap alloys of rare earth metals. The use of new soft magnetic materials has allowed us to develop magnetic conductors for a magnetic system of the scanner with low loss while maintaining high values of magnetization saturation (more than 2 T). All this allowed us to design and reduce the weight of permanent magnets used in the design of magnetic systems by almost 30 percent, and thus to reduce the cost of the devices," said Evgeny Gorelikov, the project head.

Cryogenic technologies are not required to run the new MRI machine. The power consumption of this unique scanner will be less than 1 kW, and may thus be powered with renewable energy sources such as solar panels and wind turbines. Currently, the Russian and foreign analogues of this newly developed magnetic system cost almost twice as much to implement into the medical field.

Given the fact that China is currently the world's main producer of rare-earth metals and rare-earth permanent magnets, the use of domestic magnetic components gathered in the production of MRI machines gives Russia an alternative to imports.

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