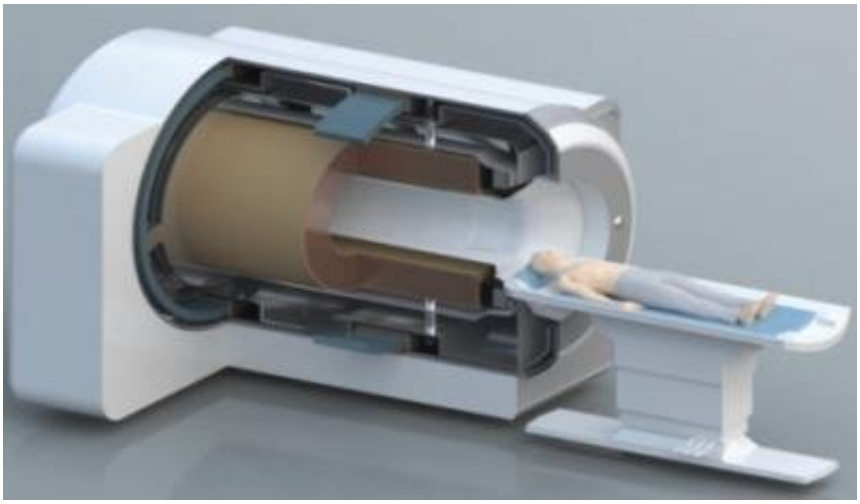
Reducing the size and weight of medical MRI equipment by more than half

July 22 2019



MRI transmits a high frequency magnetic field of thousands of hertz to the human body, and displays the image signals generated from atomic nuclei in the body in a 2D or 3D cross-sectional image. Credit: Korea Electrotechnology Research Institute (KERI)

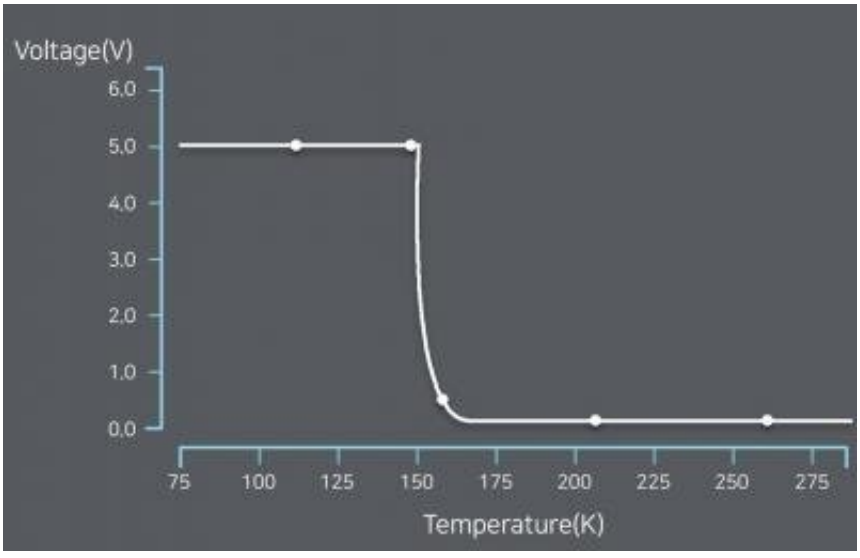
A team led by Dr. Seog-Whan Kim and Dr. Young-Sik Jo at the Superconductivity Research Center of the Korea Electrotechnology Research Institute has developed a superconducting insulation technology that can significantly reduce the size and weight of medical magnetic resonance imaging (MRI) equipment.

MRI transmits a high-frequency magnetic field of thousands of hertz to the human body and displays the image signals generated from atomic

nuclei in the body in a 2-D or 3-D cross-sectional image. It does not use radiation like X-rays and CT, so it is safe, and the required angle in the body can be freely chosen. It has very high resolution and is widely used in modern medicine.

Resolution is the most important thing for an accurate MRI diagnosis, and a stronger magnetic field results in better quality. Most existing MRIs use a superconducting electromagnet to create a powerful magnetic field. Superconductivity is the phenomenon in which metal or a compound that is cooled below a certain temperature exhibits almost no resistance to current flow. Using this principle, a superconducting electromagnet has "zero" electric resistance and much more current can flow through it than copper wire with the same cross-sectional area, which significantly improves the performance of MRI equipment.

However, superconducting electromagnets have a major flaw. Beyond a certain voltage, part of the superconducting wire can suddenly escape the superconducting state. In this case, it causes greater resistance than normal metal, and eventually heats up and burns. This phenomenon hasn't been clearly explained yet, and there is no solution.



Electrical resistance characteristics of smart insulation according to the temperature. Credit: Korea Electrotechnology Research Institute (KERI)

In order to prevent one superconducting wire from burning, 10 times more copper is currently used to wrap superconducting wire. Copper is a kind of insurance, carrying the current until a circuit breaker is activated by an overheated superconducting wire. This method uses a lot of copper and enlarges the entire volume and weight so much that the superconducting wires can't be used as much. Also, such a large amount of copper is the main reason that MRI equipment is big and heavy.

The KERI research team developed smart insulation technology that can solve the heating issue, thus significantly reducing the amount of copper used. This special technology performs insulation during normal operation so that electricity doesn't leak, and when the superconducting wire starts heating, it automatically transforms into a conductor to help electricity flow between lines.

Whereas a large amount of copper was needed in the past for each line to handle electricity, smart insulation technology can allow the distribution of electricity with nearby wires in the case of heating, so the amount of copper surrounding superconducting wire can be significantly reduced. Thus, a compact superconducting electromagnet with less risk and high current density is possible.

The developers said, "Applying smart insulation technology to MRI equipment can reduce the amount of copper by half, which means that the size of MRI equipment can be reduced by more than half," adding, "Hospitals face many difficulties due to the size and weight of MRI equipment, and this technology will enable a smaller size and lighter weight."

The research team expects that this technology will be of interest to officials of hospitals with MRI equipment, and is working on technology transfer and commercialization.

Provided by National Research Council of Science & Technology