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Potential Role of Room Temperature Superconductor LK 99 in MRI and Radiology

Som B[1]* and Sandeep SA[2]

[1]Le Bonheur Children's Hospital, The University of Tennessee Health Science Centre, Memphis, USA

[2]Department of Diagnostics, Jamshedpur, India

***Corresponding author:** Som Biswas, Le Bonheur Children's Hospital, The University of Tennessee Health Science Centre, Memphis, USA, Email: sombiswas1@gmail.com

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Abstract

Magnetic Resonance Imaging (MRI) is a vital diagnostic tool in medical imaging, revolutionizing radiology and enhancing medical diagnoses. The key component enabling MRI is the superconducting magnet, which operates at extremely low temperatures using liquid helium cooling. However, the apparently recent discovery of the room-temperature superconductor LK- 99 if true holds the potential to transform MRI technology. If LK-99 can be successfully integrated into MRI machines, it could eliminate the need for cryogenic cooling, resulting in smaller, lighter, and more affordable machines. The higher magnetic fields enabled by LK-99 could enhance image resolution and scanning speed, leading to improved accuracy in diagnoses and better patient outcomes. The unique properties of superconductors, such as zero electrical resistance and perfect diamagnetism, make them ideal for MRI applications, offering enhanced image quality and faster scanning times. The integration of superconductors in MRI technology has already led to significant advancements, including high-field MRI systems and mobile MRI units. However, challenges remain, such as the stability and cost of LK-99 and the development of MRI machines compatible with this new material. Despite these challenges, the potential benefits of LK-99 in MRI machines are promising and could revolutionize medical imaging if successfully implemented. Further research and development are necessary to explore LK-99's capabilities fully.

Keywords: Higher Magnetic Field; MRI Technology; Superconductors; Electrical Resistance; Perfect Diamagnetism

Introduction

Magnetic Resonance Imaging (MRI) is a crucial medical diagnostic tool used to obtain detailed images of the internal structures of the human body. It has revolutionized the field of radiology and significantly improved the accuracy of medical diagnoses. The core component that makes MRI possible is the superconducting magnet. Superconductors, materials that exhibit zero electrical resistance and perfect diamagnetism at low temperatures, have played a fundamental role in advancing MRI technology.

Room Temperature Superconductor LK 99

LK-99 is apparently a room-temperature superconductor that has the potential to revolutionize MRI technology.

Currently, MRI machines use liquid helium to cool their magnets to below -273 degrees Celsius, which is necessary for superconductivity. This requires a large and expensive cooling system, which limits the size and portability of MRI machines.

LK-99 could potentially eliminate the need for liquid helium cooling, making MRI machines smaller, lighter, and more affordable. This would make MRI more accessible to patients, especially those in rural areas. Additionally, the higher magnetic fields enabled by LK-99 would improve image resolution and enable faster scanning, leading to more accurate diagnoses and improved patient outcomes.

For example, a study in preprint [1] found that LK-99 could be created. If this is actually true, then it can be used to create better MRI machines, which would allow for much clearer images of soft tissues.

The potential benefits of LK-99 for MRI are significant, but it is important to note that the material is still apparently in the early stages of development. It is not yet clear how stable LK-99 is at room temperature, or how well it will perform in MRI machines. However, the research so far is promising, and LK-99 could have a major impact on the future of MRI technology.

Properties of Superconductors in MRI

Superconductors have unique properties that make them well-suited for MRI applications. One of the most important characteristics is their ability to conduct electricity without any resistance when cooled below a certain critical temperature. This property significantly reduces energy losses and allows for the creation of highly powerful and efficient magnets for MRI machines. Conventional resistive magnets, which require constant cooling and consume a substantial amount of energy, are often replaced by superconducting magnets due to their superior performance.

In addition to zero electrical resistance, superconductors exhibit perfect diamagnetism. When placed in an external magnetic field, they generate a counteracting magnetic field that completely expels the external field from their interior. This property ensures that the magnetic field generated by the superconducting magnet is concentrated and homogeneous, leading to improved image quality and spatial resolution in MRI scans.

Applications of Superconductors in MRI

The implementation of superconductors in MRI has had a profound impact on various aspects of medical imaging:

- Enhanced Image Quality: Superconducting magnets provide a highly stable and uniform magnetic field, resulting in improved image quality and reduced image artifacts. This enables radiologists to obtain clearer and more accurate images, leading to better diagnoses and treatment planning.
- Faster Scanning Times: The strong and stable magnetic fields generated by superconducting magnets allow for faster scanning times. This benefits both patients and medical facilities by reducing the overall time required for each MRI procedure.
- Open MRI Systems: Traditional closed MRI machines can be uncomfortable for some patients, particularly those with claustrophobia or larger body sizes. Superconducting magnets have enabled the development of open MRI systems, providing a more patient- friendly experience without compromising image quality.
- Functional MRI (fMRI): Superconducting magnets are essential for functional MRI studies that map brain activity. fMRI provides valuable insights into brain function and is used in research and clinical settings to study neurological disorders and cognitive processes.

Impact of Superconductors on MRI Technology

The integration of superconductors in MRI technology has led to significant advancements and innovations:

High-Field MRI: Superconducting magnets have facilitated the development of high-field MRI systems, operating at 3 Tesla (T) and beyond. Higher magnetic field strengths enable better image resolution and contrast, allowing for more accurate detection of subtle abnormalities and early disease diagnosis.

Compact and Mobile MRI: Superconducting magnets have evolved to become more compact and lightweight, making them suitable for mobile MRI units. This has improved accessibility to MRI services, especially in remote areas or during emergencies.

MRI-Guided Interventions: Superconducting magnets have opened new possibilities for MRI- guided interventions, enabling real-time visualization during procedures such as biopsies, surgeries, and minimally invasive treatments.

Here are some of the potential benefits of using LK-99 in MRI machines:

- Smaller and lighter machines
- More affordable machines
- Improved image resolution
- Faster scanning

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- ➢ More accurate diagnoses
- ➢ Improved patient outcomes

Of course, there are also some challenges that need to be addressed before LK-99 can be used in MRI machines. These challenges include:

- ✓ The stability of LK-99 at room temperature
- ✓ The cost of LK-99
- ✓ The development of new MRI machines that can use LK-99

Conclusion

Despite these challenges, the potential benefits of using LK-99 in MRI machines are significant. If the material can be truly successfully developed and used in MRI machines, it could revolutionize the way that MRI is used to diagnose and treat diseases.

Reference

1. Lee S, Kim JH, Kwon YW (2023) The Firs Room-Temperature Ambient-Pressure Superconductor.

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