Department of Electronic Control Engineering

Research on Applied Magnetic System

Shinnosuke Matsunaga
Professor, Dr. Eng.
Email : shinnosuke.matsunaga@gifu-nct.ac.jp

Research Fields	Electromagnet, Superconducting Magnet, Fusion Reactor
Keywords	High-Temperature Superconductor, Fusion Energy

Research Outline

High-Temperature Superconducting Magnet

High-temperature superconductors (HTS), which exhibit superconductivity at liquid-nitrogen temperatures (≈77 K) and maintain excellent properties even at liquid-hydrogen temperatures (≈20 K), offer significant advantages over conventional low-temperature superconductors (≤ 4 K), including drastically reduced cooling costs and minimal helium usage. Leveraging these unique HTS characteristics, our laboratory pursues foundational studies in three interconnected areas:

1) Generation of Ultra-Strong Magnetic Fields

Objective: Develop practical HTS-based superconducting electromagnets capable of producing multi-tesla fields.

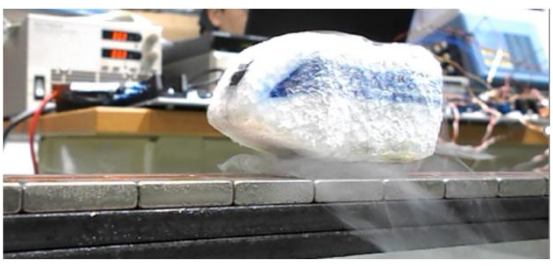
Challenges: Managing induced voltages and implementing robust quench-protection schemes to prevent thermal runaway.

Approach: Optimize coil winding architectures (e.g., multilayer, graded winding) to enhance the stability. Investigate circuit-level control using multiple magnetic-coupled electromagnets to distribute stress and suppress quench propagation.

2) Magnetic-Force-Driven Actuation

Objective: Realize frictionless, low-loss mechanical drives by exploiting the HTS bulk's magnetic flux-pinning (levitation) effect.

Approach: Characterize pinning forces in bulk REBCO samples under varying field gradients. Design and prototype non-contact actuators (e.g., HTS-levitated system, linear stages) for applications requiring high precision and minimal wear.



Fusion Outreach

We are developing and optimizing high-temperature superconducting (HTS) magnet technologies to meet the demanding requirements of next-generation fusion reactors. Our work focuses on designing robust HTS magnet system to achieve the multi-tesla magnetic fields needed for plasma confinement, while implementing advanced quench-protection schemes to ensure safe, reliable operation. In parallel, we engage in targeted outreach and education activities.