TOKYO METROPOLITAN UNIVERSITY
TMU

High Entropy Superconductor

Irradiation-tolerance HTS(REBCO)

[Keywords] Nuclear fusion, Superconductor, High entropy, Irradiation

7 AFFORDABLE AND CLEAN ENERGY
13 CLIMATE ACTION

Summary of the Invention

Tolerance of the Irradiation

This invention relates to High-entropy type Cu-oxide superconductor (hereinafter ; HE-type REBCO), incorporates the concept of high-entropy(HE) into the RE site.

One of the applications expected of superconductors is superconducting coils used in fusion reactors. However, superconductors such as Nb_3Sn, which are currently used in ITER, have a problem that the critical temperature(T_c) is dropped by irradiation of neutron rays generated by nuclear fusion reactions.

In the HE-type REBCO, when comparing T_c before and after He ion irradiation, it was found that **Tc drop was suppressed to only 1K**, in the comparative example YBCO was 13K (Fig.1).

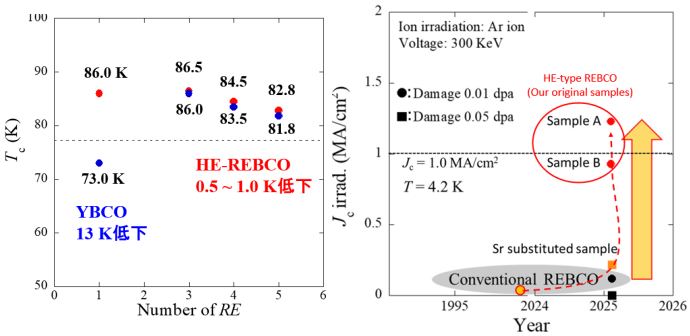
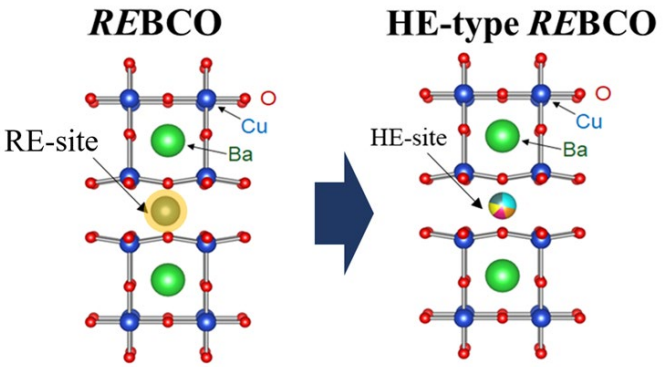


Fig.1 (left) : comparison of Tc drop after irradiation
Fig.2 (right) : Jc of HE-type REBCO



Potential of high Jc

In the use of superconductors, including fusion reactors, the critical current density Jc is an important performance metric. We aim to further improve irradiation tolerance and the performance of the critical current density Jc by optimizing the material type and amount of elements introduced into the rare-earth sites and so on. Additionally, we are also conducting comprehensive research by combining HE-type REBCO with various other materials. At present, we have successfully developed HE-type REBCO with a significantly higher critical current density Jc than conventional REBCO (Fig.2) (For details of the materials, please contact us as they are not publicly disclosed yet).

Inventors： YAMASHITA Aichi et. al.
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Invention of Tokyo Metropolitan Public University Corporation

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Use of the Invention

In 2007, when the ITER Project was established, there were only about five fusion startups, and are now grown to more than 100, forming a large market.

Ensuring high economic efficiency is important for the practical application of fusion power generation. In recent years, miniaturizing fusion reactors is a attentional development theme. However, miniaturization makes it difficult to design thick and large irradiation protection walls, increasing the amount of irradiation per unit area of superconducting coils. In such a situation, the superconductors cannot persist their superconducting properties due to irradiation damage shortly after the reactor starts operating, and it will result in a very economically inefficient system.

This invention has the potential to significantly extend the lifespan of superconducting coils, which are one of the most essential components in fusion reactors.

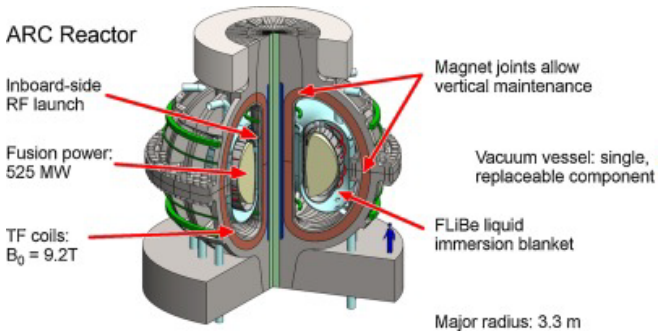

Image from :
B.N. Sorbom *et al.*, *Fusion Engineering and Design* **100**, 378-405 (2015)

About our Laboratory

We have globally pioneered the development of HE-type REBCO. We hope to collaborate with fusion reactor manufacturers, superconducting magnet manufacturers, superconductor tape/wire manufacturers and superconductor material manufacturers to identify and achieve the requirement for the practical application of this invention. Anyone interested in this invention are welcome to discuss joint development.

Additionally, the lab aims to create new materials and new functional materials, not only superconductors but also other materials such as thermoelectric materials, based on the concept of high entropy alloying. Please feel free to contact us.

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