Development of High-Entropy-Type REBCO Superconductor with Multiple Sites Substitution $(Y, Gd, Dy, Yb)_{0.25}Ba_{2-x}Sr_xCu_3O_{7-\delta}$

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High-entropy alloys (HEA) are typically defined as alloys with over five principal elements with concentrations between 5 and 35at%, resulting in high configurational mixing entropy. They have been reported to exhibit excellent mechanical properties because of local lattice distortion that greatly contributes to solid solution strengthening [1]. Apart from the "alloys", we have been developing High-Entropy-Type (HE-Type) "compounds" by incorporating the HEA concept into the specific crystal sites. So far, we have been developing HE-type $RE Ba_2Cu_3O_{7-\delta}$ with multi-element solid solution for *RE* sites to improve the superconducting properties of $RE Ba_2Cu_3O_{7-\delta}$ [2–5].

Recently, the improvement of mechanical properties against the high energy particles irradiation, which originated from the increase of migration barrier by the large atomic distortion and disorder, was reported in HEA [6]. This result motivated us to expect the acquisition of new functionality such as high irradiation resistance against high energy particles such as neutron for HE-type REBCO. To date, we have found that HE-type REBCO superconductors have high irradiation resistance in superconducting transition temperature against the He ion irradiation [5], suggesting that these should be promising candidate materials for superconducting magnets application in a next-generation nuclear fusion reactor.

In this study, we introduced simultaneously substitution of Sr for Ba sites with multi-element solid solution of *RE* sites (Fig. 1a). HE-type $RE Ba_{2-x}Sr_xCu_3O_{7-\delta}$ thin films were prepared using a pulsed laser deposition (PLD) method, and the superconducting properties were evaluated before and after He ion irradiation. As a result, the HE-type samples retained their superconducting state even after high irradiation damage where the superconductivity disappeared in YBCO (Fig. 1b). We will discuss the multiple-site substitution on the superconducting properties before and after irradiation.

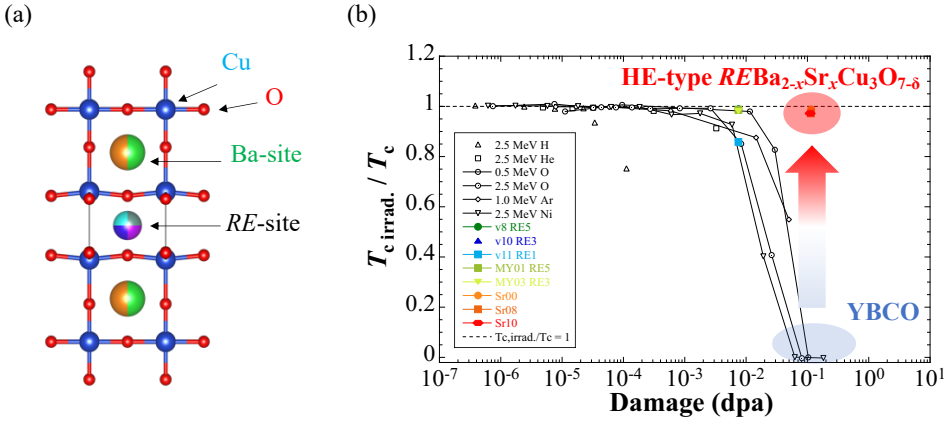

Fig. 1 (a) Crystal structure and (b) T_c vs Damage of HE-type $RE Ba_{2-x}Sr_xCu_3O_{7-\delta}$.

References

[1] M.-H. Tsai *et al, Mater. Res. Lett.* **2**, 107 (2014).
[2] A. Yamashita *et al., R. Soc. Open Sci.* **9**, 211874 (2022).
[3] Y. Shukunami *et al., Physica. C.* **572**, 1353623 (2020).
[4] A. Yamashita *et al., Jpn. J. Appl. Phys.* **61**, 050905 (2022).
[5] A. Yamashita *et al.,* Patent: 2023-087946, Date：2023/5/29.
[6] Q. Xu *et al., Sci. Rep.* **11**, 608 (2021).