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Rectification by Superconducting Diodes Made of REBCO Films

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A superconducting diode with an asymmetric I_c has been proposed as a novel rectifying element operating at cryogenic conditions [1]. It has an opposite current-voltage properties compared with the semiconductor diode. In the cryogenic applications, the superconducting diode has a potential to be used as an efficient rectifiers or current limiters. In our previous study, we fabricated the tailored REBCO films to achieve a large rectification rate and developed an prototype element made of the REBCO film [2]. In this study, the rectification properties of the superconducting diodes were investigated at various magnetic fields and temperatures in order to optimize the operating conditions.

BaHfO₃-doped SmBa₂Cu₃O_y films were fabricated on LaAlO₃ substrates with a thicknesses of 1000 nm using a pulsed laser deposition method. The films were processed into micro bridges with a width of 100 μm. Current-voltage characteristics including the reverse current were measured at 0-9 T and 40-90 K by the four-probe method. An asymmetry $Asym.$ was defined as a ratio between a differential and an average amplitude of I_c for the different current direction.

Figure 1(a) shows I - V characteristics in the REBCO film at 65 K and 0.3 T along the in-plane direction. It is apparent that the I_c is about twice as different depending on the current direction. $Asym.$ was plotted for the temperature and the magnetic field as shown in Fig. 1(b). The optimal temperature for the $Asym.$ was about 65 K which corresponds to the temperature of the sub-cooled liquid nitrogen. Therefore, we conclude that the superconducting diode made of the REBCO film is expected to be used in the liquid nitrogen. On site, we will discuss an origin of the asymmetric I_c to optimize the diode with the larger rectification rate.

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[1] X. Jiang et al., Phys. Rev. B 49, 9244 (1994).

[2] Y. Tsuchiya *et al.*: Abstracts of ISS conference (2018).

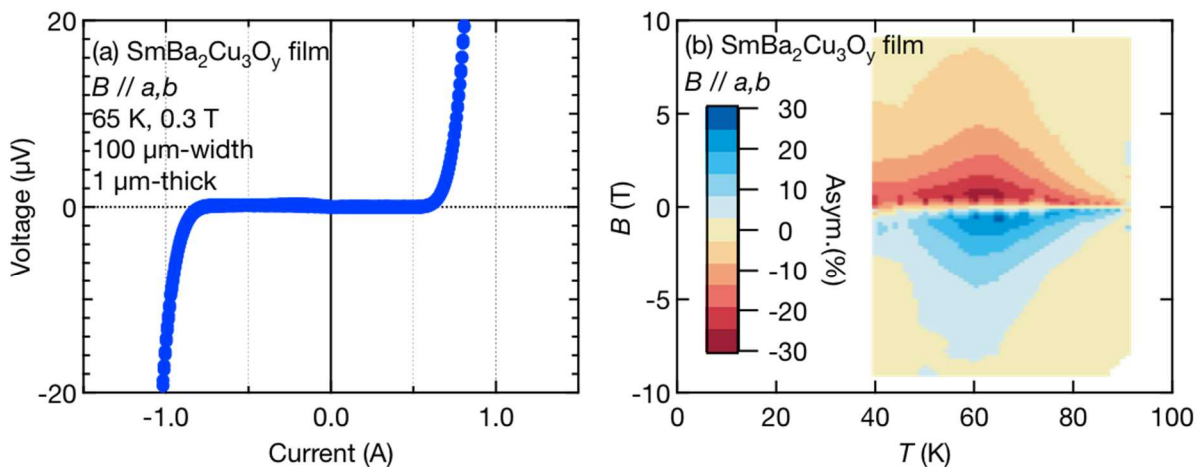


Fig. 1 (a) Asymmetric current-voltage characteristics in SmBa₂Cu₃O_y films at 65 K and 0.3 T. (b) Temperature and field mapping of the asymmetry of the critical current.

Keywords: REBCO film, Superconducting diode, Critical current