Fabrication of 122-type iron-based superconductor round wires using harder sheath materials

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The 122-type IBSs superconducting wires and tapes are fabricated using the powder-in-tube (PIT) method, which is relatively inexpensive [1]. For practical applications of superconducting wires and tapes, the widely accepted tranport J_c threshold is 100 kA cm^{-2} under the standard condition of 100 kOe at 4.2 K [2]. From a practical application perspective, superconducting round wires offer advantages over tapes, as the round wires can be wound into coils of various shapes. The highest transport J_c value for the 122-type IBS round wires under the standard condition is 71 kA cm^{-2} in Cu/Ag-sheathed (Ba,Na)Fe_2As_2 round wire, which is processed using the hot-isostatic pressing (HIP) technique at 700°C [3,4]. The HIP process is expected to be undesirable in industry because of the difficulty in setting up the equipment. The highest transport J_c value under the standard condition for the 122-type IBS round wires without the aid of the HIP process is 44.5 kA cm^{-2} in stainless steel (SS)/Cu/Ag-sheathed (Ba,K)Fe_2As_2 round wire, which is heated at 730°C under ambient pressure [5]. In 2024, Li *et al.* achieved transport J_c of ~100 kA cm^{-2} under the standard condition for Cu/Nb/Ag-sheathed (Ba,K)Fe_2As_2 tape, which is heated under atmospheric pressure at 880°C [6].

In this study, we fabricated (Ba,Na)Fe_2As_2 round wire using Cu/Nb/Ag sheath, as shown in Fig. 1(a). After the drawing process, the wire was finally heated at 750°C for 2 h in evacuated silica tube. Figure 1(b) shows transverse X-ray computed tomography (CT) image for the wire. We will discuss the J_c performance of wires subjected to various heat treatment conditions, as well as trial fabrication of wires using other sheath materials.

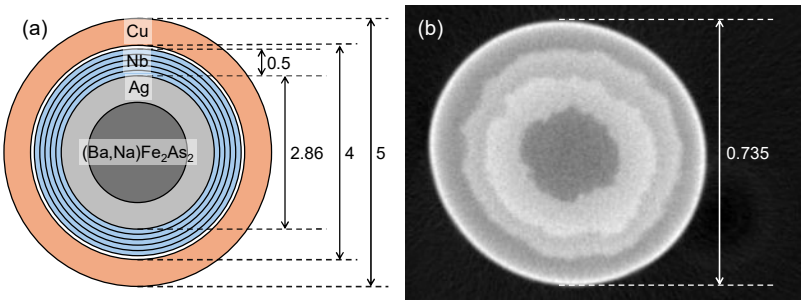

Figure 1. (a) Blueprint of (Ba,Na)Fe_2As_2 round wire using Cu/Nb/Ag sheath before the final drawing process. (b) Transverse X-ray computed tomography (CT) image for the wire. Units of the numbers in the figures are mm.

References

[1] Y.-W. Ma *et al.*, *Physica C* **469**, 651 (2009).
[2] H. Hosono *et al.*, *Mater. Today* **21**, 278 (2018).
[3] T. Tamegai *et al.*, *J. Phys. Conf. Ser.* **2545**, 012011 (2023).
[4] S. Pyon *et al.*, *Physica C* **615**, 1354354 (2023).
[5] C.-D. Fu *et al.*, *Supercond. Sci. Technol.* **37**, 035015 (2024).
[6] W.-C. Li *et al.*, *Supercond. Sci. Technol.* **37**, 105018 (2024).