WBP3-1

Fabrication and Characterizations of $KCa_2Fe_4As_4F_2$ Superconducting HIP Wires

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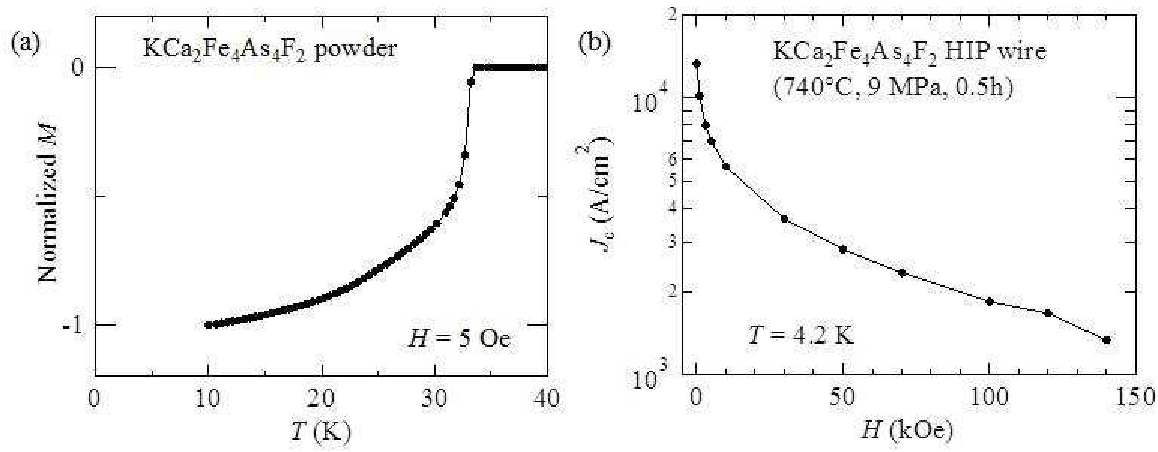
Iron-based superconductors (IBSs) are one of the promising candidates of future high-magnetic-field applications because of their high critical temperature, T_c, high critical current density, J_c, and high upper critical field, H_{c2}. Most of researches on IBS wires and tapes have been conducted using 122-type compounds ($(Ba,K)Fe_2As_2$ or $(Sr,K)Fe_2As_2$), and a practical level of J_c above 100 $kAcm^{-2}$ has been achieved in these wires and tapes. On the other hand, other IBS compounds are still investigated as raw materials for superconducting wires and tapes, such as $SmFeAsO_{1-y}$ and $CaKFe_4As_4$, whose J_c at 4.2 K in self-field are approximately 40 and 90 $kAcm^{-2}$, respectively. Here, we report the fabrication and characterizations of $KCa_2Fe_4As_4F_2$ round wires for the first time. Polycrystalline $KCa_2Fe_4As_4F_2$ powder was prepared by solid-state reaction and its T_c was evaluated from magnetization measurement as shown in figure (a). Superconducting wires were fabricated by powder-in-tube (PIT) method and hot-isostatic-press (HIP) technique. The self-field J_c of the $KCa_2Fe_4As_4F_2$ HIP wire fabricated at 740°C under a high pressure of 9 MPa for 0.5h, exceeded 10 $kAcm^{-2}$ as shown in figure (b). Details of the optimization of the round wire to achieve large J_c values and extensive characterizations of wires using X-ray diffraction and magneto-optical imaging will be presented.



Keywords: Iron-based superconductor, Critical current density, PIT-HIP wire, KCa2Fe4As4F2

WBP3-2

Effect of the metallic oxide mix-doping on the microstructure and superconducting properties of Bi-2223 Ag/tapes

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The Bi-2223 Ag/tapes with the composition $Bi_{1.8}Pb_{0.4}Sr_{1.9}Ca_{2.1}Cu_{3.5}O_y$ + Xn (X1: un-doped; X2: 1wt% MgO + 1wt%Ag_2O mix-doped; X3: 1wt% MgO + 1wt%Ag_2O + 0.05wt%SnO_2 mix-doped; X4: 1wt% MgO + 1wt%Ag_2O + 0.05wt%B_2O_3 mix-doped; X5: 1wt% MgO + 1wt%Ag_2O + 0.05wt%Li_2O; X6: 1wt% MgO + 1wt%Ag_2O + 0.05wt%La_2O_3 mix-doped) were prepared by sintering at 837℃ for 120 h after partial-melting at 850℃ for 1 h. The B_2O_3 mix-doping (X4) and B_2O_3 mix-doping (X5) decrease the conversion of Bi-2212 phase to Bi-2223 phase. However, the SnO_2 mix-doping (X3) and La_2O_3 mix-doping (X6) increase the conversion of Bi-2212 phase to Bi-2223 phase in comparison with the un-doping (X1). The tape with 1wt% MgO + 1wt%Ag_2O + 0.05wt%La_2O_3 mix-doping shows the highest proportion of Bi-2223 phase and the highest critical current density.

Keywords: Bi-2223, mix-doping, microstructure, superconducting

WBP3-3

Bi2212 precursor powder and Bi2212 wires synthesized based on nanospray combustion technology

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Nanospray combustion technology is an attractive way to make Bi2212 precursor powder for both its time-saving process and its good property in powder as well as in wires made by the powder. By adjusting the related parameters of nanospray combustion technology, mainly including the concentration of the Bi2212 precursor liquid, the flow rate of the carrier gas and the combustion temperature, we had synthesized Bi2212 precursor powder. By optimizing the related parameters, Bi2212 precursor powder with smaller particle size, good compositional uniformity and phase purity was obtained. Preliminary results showed Bi2212 wires synthesized based on this powder held a nearly equivalent Ic with the wires made based on the co-precipitation powder. It's believed that wires with improved performance would be obtained by using the precursor powder synthesized by the nanospray combustion technology in the near future.

Keywords: Nanospray combustion technology, Bi2212 precursor powder, Bi2212 wires

WBP3-4

Development of Bi-2223 high temperature superconducting tapes in NIN

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Bi-2223 high temperature superconducting tapes are called the First generation High temperature Superconductors (HTS) based on their sophisticated fabrication technique and stable mechanical structures. So far, there have already been many demonstration projects successfully proved the reliability of Bi-2223 HTS tapes. Therefore, the development of the fabrication technique is very important for the further improvement of superconducting related techniques. Northwest Institute for Non-Ferrous Metal Research (NIN) started the study of Bi-2223 tapes since 1990s. Recently, new improvements based on the novel spray pyrolysis techniques for precursor powders fabrication, the introduction of groove rolling process into cold working process, as well as the investigation and optimization of rolling process have been achieved and the current capacity of Bi-2223 tapes has been enhanced. Comparing with the traditional coprecipitation process we adopted for nearly 20 years, the spray pyrolysis technique exhibits many advantages, such as high uniformity of particle size and chemical composition, large production capability and short process path, which can all be beneficial to the industrial fabrication of precursor powders. So with the optimization of many important parameters, including pyrolysis temperature, airflow rate, and concentration of precursor solution, the critical current Ic of Bi-2223 tapes with spray pyrolysis powders has been improved from 80 A to 110 A.On the other hand, groove rolling process has completely different deformation mechanism with traditional drawing process, which is beneficial to the enhancement of filament density, and the uniform deformation of wires. Therefore, by introducing groove rolling process to replace certain steps of drawing process, the filament density has been improved for nearly 10%, and the enhancement of critical current for nearly 20% has been obtained.Finally, the optimization of rolling parameters, for example starting wire diameter and rolling passes have both been completed. And with the enhancement of filament texture, the current capacity of obtained tapes has been further enhanced. The maximum engineering critical current density Je of 10 kA/cm-2 has been obtained with the heat treatment performed under ambient pressure.

Keywords: Bi-2223, High temperature superconductor, Precursor powder, Groove rolling

WBP3-5

Fabrication of $(Ba,Na)Fe_2As_2$ round wires and tapes using HIP process

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Iron-based superconductors have high critical current density under high magnetic fields, and are expected to be applied as wires under high magnetic fields. Among them, researches on the wires of K-doped 122-based iron-based superconductors have been extensively advanced. In recent years, researches on wires and tapes of Na-doped $(Sr,Na)Fe_2As_2$ and $(Ba,Na)Fe_2As_2$ have been undertaken [1], and we have reported a record-high value of critical current density (J_c) of 40 kA/cm^2 at 100 kOe in $(Ba,Na)Fe_2As_2$ round wire [2].

In the present study, we fabricated round wires and tapes of $(Ba,Na)Fe_2As_2$ using HIP (hot isostatic press) process, and evaluated their transport J_c. Polycrystalline powders were synthesized by using pre-synthesized precursors (BaAa, NaAs, Fe_2As), which is simpler than the method of mixing raw materials in a planetary ball mill. Compared with the transport J_c (95 kA/cm^2 under self field, 40 kA/cm^2 at 100 kOe) of the wire in the previous study [2], the transport J_c of the present HIP round wire is higher at self-field (129 kA/cm^2), but slightly lower at 100 kOe (37 kA/cm^2) as shown in the figure. In addition to the results of the round wire mentioned above, we plan to discuss detailed characterizations of the tape fabricated from the same powder. In particular, X-ray diffraction is extensively applied to the evaluation of the degree of texturing of the wire and tape.

[1] Suwa *et al.* , Appl. Phys. Express **11**, 063101 (2018).
[2] Miyawaki *et al.*, 74th Annual Meeting of the Physical Society of Japan 16pS305-8 (2019).

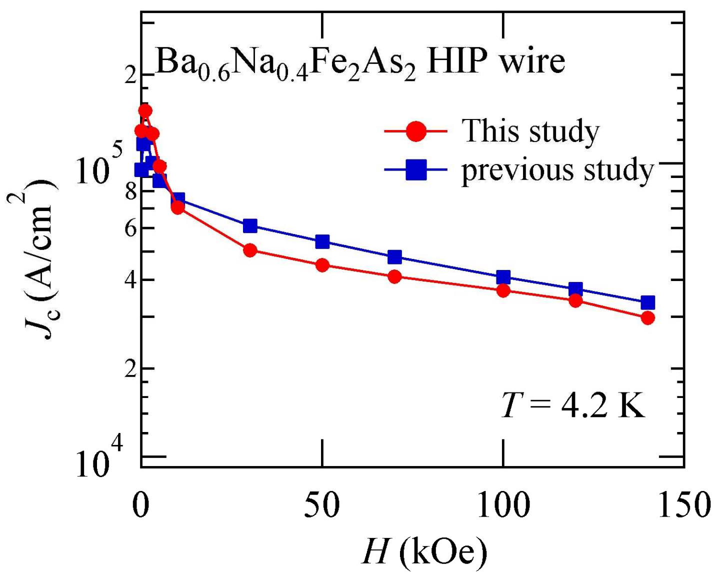

Figure. Magnetic field dependence of transport J_c of $Ba_{0.6}Na_{0.4}Fe_2As_2$ HIP round wires in this study and previous study [2].

Keywords: Iron-based superconductor, Critical current density, HIP round wire, HIP tape