The World's First 100 meter-class Iron-based Superconducting Wire

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October 04, 2016 (HP116). Iron-based superconductors (IBSs) are very promising in high-field applications, since they have relatively high superconducting transition temperatures (T_c) up to 55 K, very high upper critical fields (H_{c2}) above 100 T and very low superconducting anisotropy of 1-2 (e.g. for 122 family). However, for large-scale applications, high-performance wire and tape conductors with sufficient length are essential. Studies on the grain boundary nature in '122' IBS epitaxial film suggested that intergrain currents across mismatched grains in iron-based superconductors are deteriorated to a lesser extent than in YBCO superconductors [1]. Therefore, traditional powder-in-tube (PIT) method, which has been utilized in commercial Nb_3Sn, Bi-2223 and MgB_2 wires, is promising for IBS wires manufacture.

Early in 2008 and 2009, the first '1111' and '122' IBS wire was fabricated by PIT method, respectively [2]. By using silver as sheath material to prevent the non-superconducting reaction layer formed during heat treatment, *ex-situ* precursor to improve the quality of superconducting phase and mechanical deformation such as flat rolling, hot isostatic pressing and uniaxial pressing to improve the mass density of superconducting cores, the transport J_c of '122' IBS wires and tapes has been rapidly increased in the recent years. High transport J_c exceeding 10^5 A/cm^2 at 4.2 K and 10 T has been achieved in densified and textured $Sr_{1-x}K_xFe_2As_2$ tapes, demonstrating that the J_c performance has reached the level desired for practical applications [3].

Based on the experience in high-performance short samples and subsequently developed multifilamentary wire process [4], our group started the research for long-length iron-based superconducting wires. In 2014, by a scalable rolling process, we fabricated the first 11 m long $Sr_{1-x}K_xFe_2As_2$/Ag tape. The J_c of this tape exhibits a uniform distribution, fluctuating between 2.12 and 1.68×10^4 A/cm^2 (4.2 K, 10 T), with an average J_c value of 1.84×10^4 A/cm^2 [5]. After that, we moved on to fabricate 100 meter-class tapes, for which higher-level homogeneity of precursor powder and uniformity of deformation process are indispensable. In August 2016, we successfully fabricated a 115 m long $Sr_{1-x}K_xFe_2As_2$/Ag superconducting tape using the traditional powder-in-tube process, which shows a uniform J_c distribution throughout the tape with a minimum J_c of 1.2×10^4 A/cm^2 (4.2 K, 10 T), as presented in Fig.1 and 2. This milestone work has been announced in the 2016 Applied Superconductivity Conference recently held in Denver, USA [6].

The 115 m long $Sr_{1-x}K_xFe_2As_2$/Ag tape is the world's first 100 meter-class iron-based superconducting wire, which demonstrates the great potential in large-scale manufacture, and is of great significance for promoting the practical application of iron-based superconductors. We believe that for iron-based superconducting wires, there is still much room for enhancing J_c performance and reducing material costs, and now the path towards real application is being opened up.

FIG. 1 The world's first 100 meter-class iron-based superconducting wire developed in the Institute of Electrical Engineering, Chinese Academy of Sciences (IEECAS).

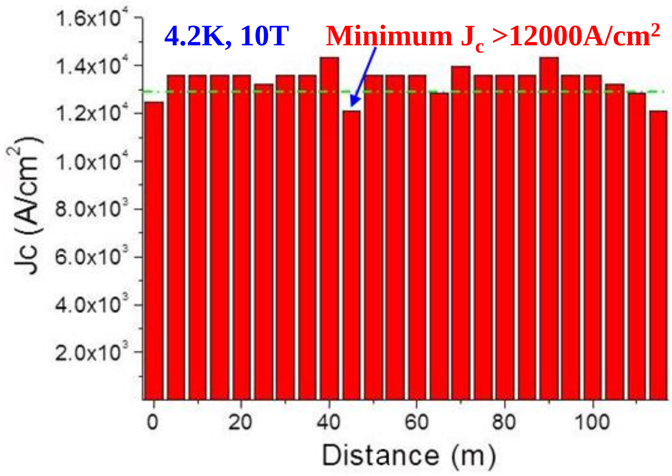

FIG. 2 The distribution of critical current density J_c throughout the 115 m long Sr122 wire.

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