

Fabrication and Characterization of CaKFe₄As₄ Superconducting Bulk

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Iron-based superconductors are considered as promising candidates for high magnetic field applications owing to their large and nearly isotropic upper critical field. Superconducting wire and bulk development are primarily conducted using 122-type materials such as Ba_{1-x}K_xFe₂As₂. We have successfully developed 1144-type iron based superconductor such as CaKFe₄As₄ (CaK1144) [1]. In study using single/poly-crystalline sample of CaK1144, we discovered that the unique stacking faults in its structure was important role for flux pinning mechanism and induced high critical current density properties [2,3]. Consequently, we focused CaK1144 and are developing polycrystalline CaKFe₄As₄ superconducting bulk.

To simply fabrication of superconducting bulk, we focused spark plasma sintering (SPS) technique. CaK1144 superconducting bulk. High-density CaK1144 (~96%) bulk can be easily fabricated using SPS technique (SPS bulk) and achieved high J_c values of 81 kA cm⁻² (18 kA cm⁻²) at 4.2 K under self-field (5 T) [4]. J_c of polycrystalline samples is generally limited by the grain boundary characteristics that determine inter-grain J_c . In previous study, a Ba(Fe_{1-x}Co_x)₂As₂ bulk with c-axis texture (the c-axes of grains are aligned along the pressure applied to pelletize powder) showed enhancement of J_c behavior, demonstrating the effectiveness of the grain alignment [5]. So, we further focused on spark plasma texturing (SPT) technique to induced grain alignment in CaK1144 bulk (SPT bulk). The grain size of SPT bulk was smaller than that of SPS bulk. Moreover, the dominant orientation of grains is (001) along the pressure direction, confirming the c-axis texture inside the SPT bulk (See Fig. 1) [6]. The J_c values of the SPT bulk are 127 kA cm⁻² (26 kA cm⁻²) at 4.2 K under self-field (5 T), which are higher than those of our SPS bulk.

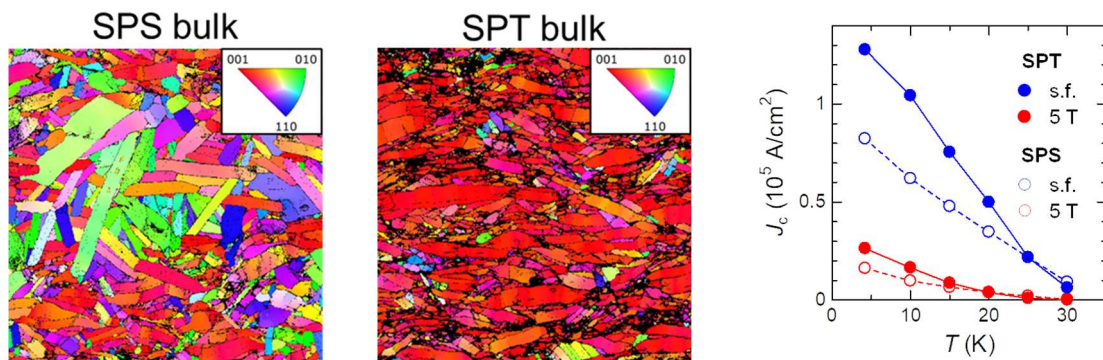


Fig. 1 (left) Grain orientation analysis of SPS and SPT bulk performed on the cross section and (right) Temperature dependence of J_c ($J_c - T$) for SPS and SPT bulk.

References

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