Fabrication of Bi-2223 High Temperature Superconducting Tapes with Groove Rolling Process

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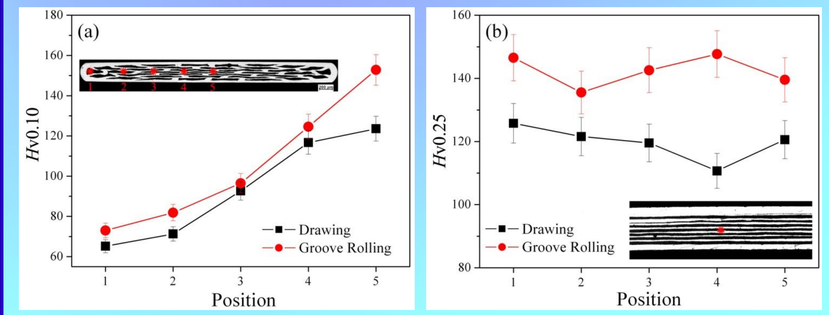
Introduction

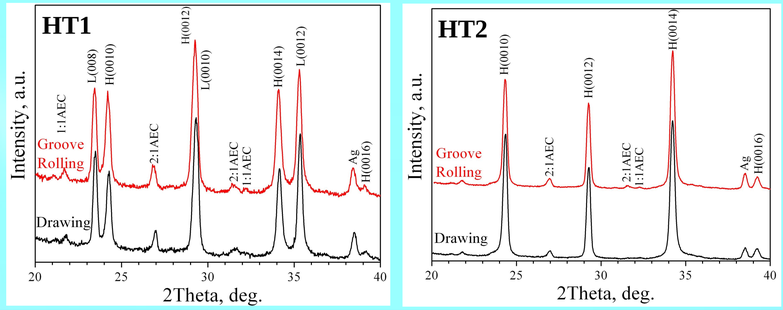
Since the first discovery in 1987 [1], $Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$(Bi-2223) superconductors with the critical temperature of ~110 K has been considered as one of the most promising candidates for the practical applications of high temperature superconductors (HTS). In order to achieve stable and reliable structure for practical applications, powder-in-tube (PIT) process has been well developed and considered as the most proper technique [2]. Till now, massive production of Bi-2223 tapes has been realized by certain commercial companies, namely Sumitomo Electric Industries (SEI) [3] and American Superconductor Corporation (AMSC) [4]. Many demonstrative applications of Bi-2223 HTS tapes involved with the fabrication of cables, motors, current lead as well as magnets have been successfully realized. In our study, 37 filamentary Bi-2223 HTS tapes with the precursor powders fabricated by co-precipitation process have been prepared with PIT process. After reassemble the single filamentary wires into Ag-alloy sheath, the multi-filament bullet was drawn to a certain diameter, then groove rolled to 2 mm with dodecagon shape dies, then drawn to round shape again. By comparing with the tapes with traditional drawing process, the influences of groove rolling on the filament density, phase formation mechanism, microstructures as well as the current capacity were all systematically studied.

Results and Discussion

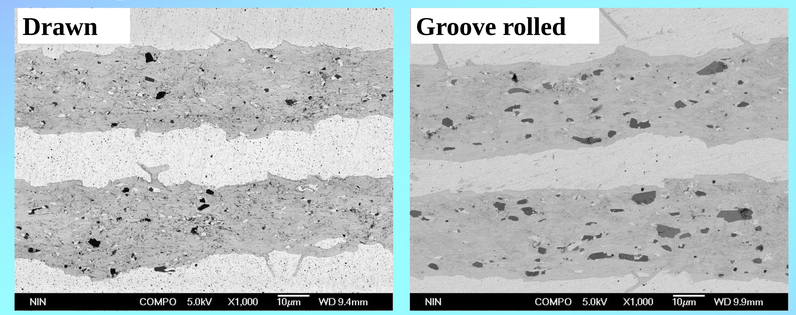
Comparing with traditional drawing process, the Groove rolling process can obviously improve the filament density of Bi-2223 green tapes as well as the uniformity of density distribution.



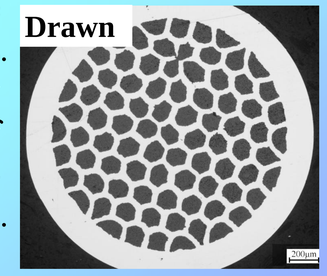
Groove rolling can enhance the Bi-2223 formation process after HT1, but more AEC phase appears after HT2.

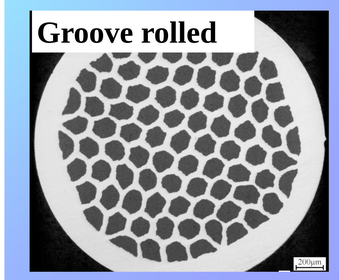


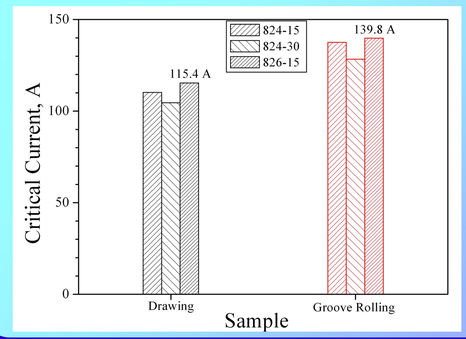
Obviously enhanced density can be observed in Groove rolled tapes.



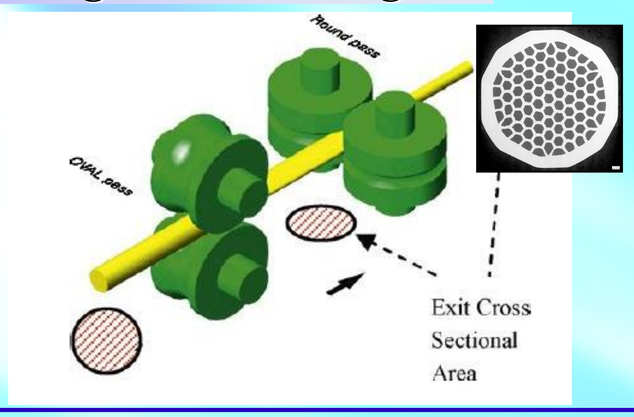
- Improved I_c of ~140 A can be obtained in Groove rolled tapes.
- Groove rolling can effectively improve the uniformity of filament deformation in Bi-2223 wires with more filaments.







Deformation process during Groove rolling



- Groove rolling can maintain the integrity of filament by maintaining higher Ag ratio than drawing process

Ag ratio (%)	Drawn (@4.00 mm)	Groove Rolled (@4.00 mm)	Drawn after Groove rolling (@1.86 mm)
Bi-2223	57.8	63.1	59.9

References

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[3] K. Hayashi, T. Hikata, T. Kaneko et al., IEEE Trans. Appl. Supercond., 11(2001)3281.
[4] L. Masur, D. Parker, M. Tanner et al., IEEE Trans. Appl. Supercond., 11(2001)3256.