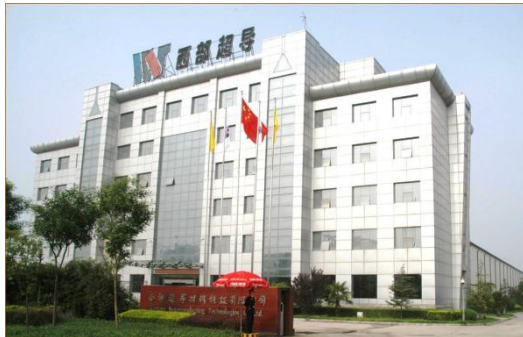




**Western Superconducting Technologies Co.,
Ltd**

Nb₃Sn superconducting wire For HEP at WST



March, 2015

FCC-WEEK 2015



Targets for future R&D on Nb₃Sn for HEP application

Strand diameter	(mm)	0.5~1.0
Non-Cu J _c (16T, 4.2K)	(A/mm ²)	≥1500
u ₀ ΔM (1T, 4.2K)	(mT)	≤150
σ(u ₀ ΔM) (1T, 4.2K)	(%)	≤4.5
D _{eff}	(um)	≤20
RRR		≥150
Unit length	(Km)	≥5



At present, only Internal Tin (IT) and Powder in Tube (PIT) are possible choices to reach the targets for HEP application.



Progress about IT Nb₃Sn strand in WST

Strand diameter	(mm)	0.5~1.0
Non-Cu J _c (12T, 4.2K)	(A/mm ²)	≥2500
u ₀ ΔM (1T, 4.2K)	(mT)	\
σ(u ₀ ΔM) (1T, 4.2K)	(%)	\
D _{eff}	(um)	≤90
RRR		≥80
Unit length	(Km)	≥1

A huge improvement in Non-Cu J_c of IT Nb₃Sn strand has been made in recent 2 years, though the gap is still indescribable.



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Future work in WST

Improvement based on the present IT Nb₃Sn strand

increase **Non-Cu J_c**

increase the Nb content of strand

decrease **D_{eff}**

increase the numbers of sub-elements

increase **RRR**

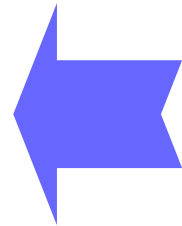
improve heat-treatments

temperature (650°C ~700°C)

time (40~70hs)

increase **Unit length**

improve the process control



At present, the strand designed for high-field magnets use contains 54 sub-elements with the Nb content of 50%.

Future work in WST

Improvement based on the present IT Nb₃Sn strand

- Increase Nb content

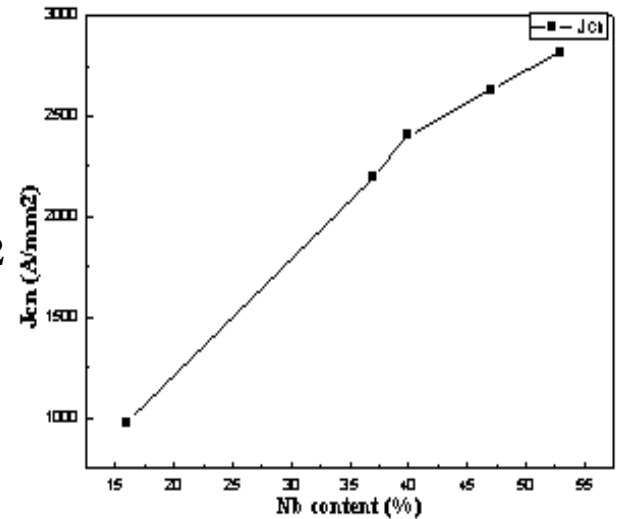
17% → 34% → 58%

1000A/mm² → 2300A/mm² → >3000A/mm²

- Increase the numbers of subelements

54 → 84 → hundreds of

D_{eff} : ~80u → ~60u → <20u



the relationship between J_{cn} and Nb content



Future work in WST

Improvement based on the present IT Nb₃Sn strand

➤ Improve heat treatment

reducing the heat treatment time properly 70hs → ~40hs

increasing the thickness of Nb barrier properly 5um → 7um

trying on new heat treatment schedule

➤ Improve the process control

controlling the whole process strictly, that is material cleaning,

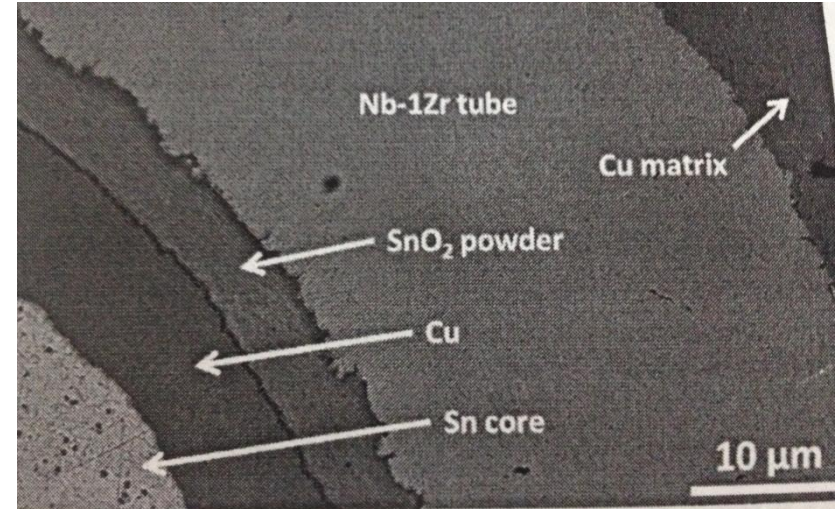
assembly, and drawing

improving the environment of strand producing

Future work in WST

Challenge on APC in Nb₃Sn strand*

- ZrO₂ precipitates will form during the heat treatment;
- The precipitates refines the Nb₃Sn grain size.



SEM image of element

The SnO₂ powder will be the risk of breakage of strand drawing.

* X. Xu, M. Sumption, X. Peng, and E. W. Collings, "Refinement of Nb₃Sn grain size by the generation of ZrO₂ precipitates in Nb₃Sn wires.



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Thanks for your attention!