Fundamental study on the effect of Zn addition into Cu matrix in DT method Nb_3Sn conductors

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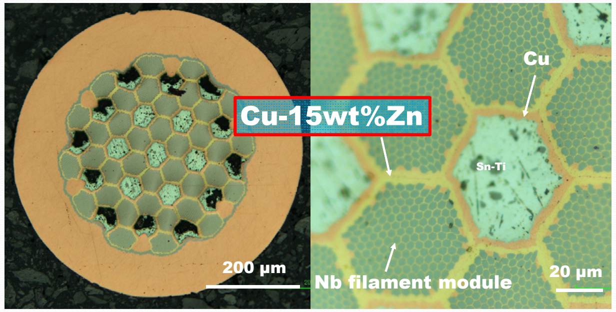
Abstract

Kobe Steel has developed **brass matrix DT** (distributed tin) method Nb_3Sn wires, aiming to achieve both high J_c performance and high robustness, in collaboration with **NIMS**.



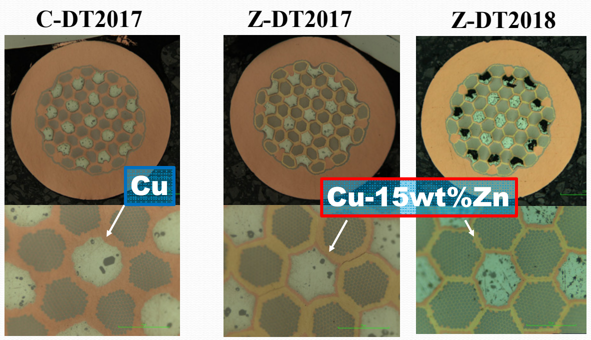
Wire ID: Z-DT2018

In this work,

Measurement of Non-Cu J_c of the developed brass matrix DT wires.

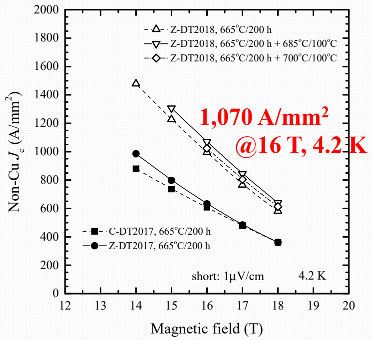
Microstructural study on diffusion reaction behavior,
especially during the pre-annealing,
towards more detailed optimization of process parameters
and further J_c improvement

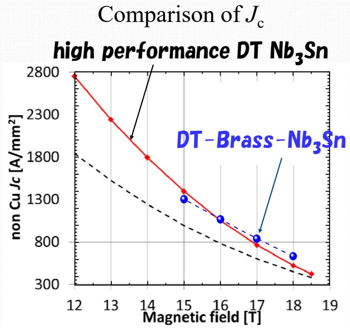
	C-DT2017	Z-DT2017	Z-DT2018	High spec DT
Wire diameter (mm)	0.6	0.6	0.6	
Nb ratio within barrier (%)	38.6	38.6	46.6	48.0%
Nb filament diameter (μm)	3.4	3.4	3.4	1.2 μm
Matrix of Nb module	Cu	Cu-15wt%Zn	Cu-15wt%Zn	Cu
Matrix of Sn core	Cu	Cu	Cu	
Nb module diameter (μm)	45	45	45	32 μm
Sn diffusion distance (μm)	45	45	45	32 μm
Ti ratio within barrier (wt%)	0.7	0.7	0.6	0.44
Zn ratio within barrier (wt%)	0	5.6	3.9	
Nb / Sn atomic ratio	2.24	2.24	3.0	
Cu / non-Cu ratio	1.12	1.12	1.12	



Design parameters have not optimized yet.

Non-Cu J_c-B characteristics for fabricated wires

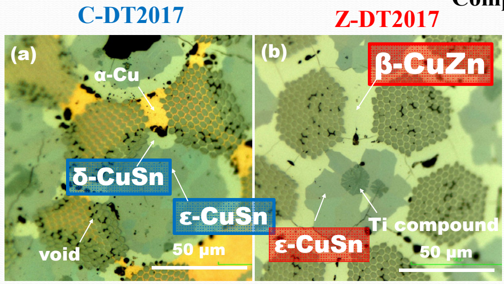




Primary heat treatment: 210 °C/6 h + 350 °C/18 h + 460 °C/28 h, + around 570 °C/180 h + 665 °C/200 h

Microstructural change

Completely different

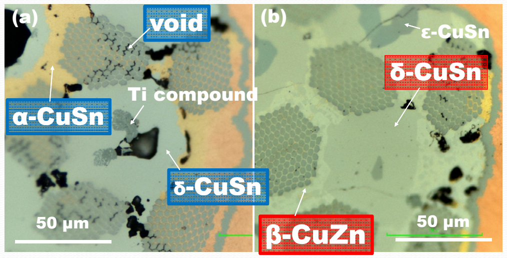


after 400 °C/200 h

β-CuZn phase forms in Z-DT.

Better Sn penetration into Nb module.

Fewer voids form.

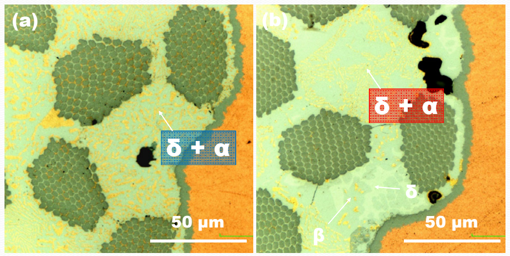


after 400 °C/200 h + 480 °C/50 h

β-CuZn phase forms in Z-DT.

Better Sn penetration into Nb module.

Fewer voids form.



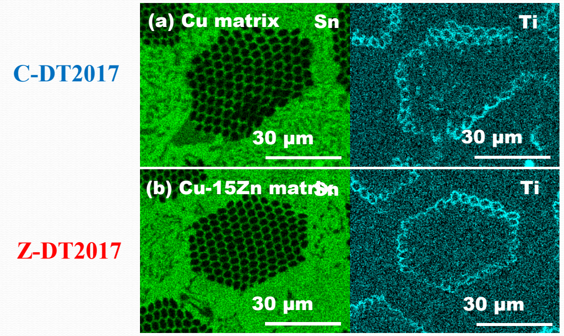
after 400 °C/200 h + 535 °C/50 h

δ and β phases started to decompose.

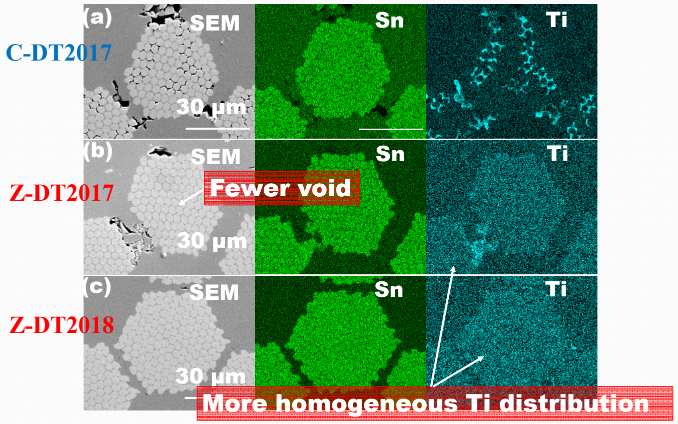
Dendritic mixed phase of δ + α

Problem of Ti Segregation, when doping Ti to Sn core

after 400 C/200 h + 535 C/50 h



after Primary heat treatment



Conclusion

- **Brass DT Nb_3Sn** wires have been developed.
- **Zn addition** results in **β-CuZn** formation, suppressing growth of δ + ε phases that often cause void growth.
- **Zn addition improves Sn and Ti distribution** in the Nb filament pack.