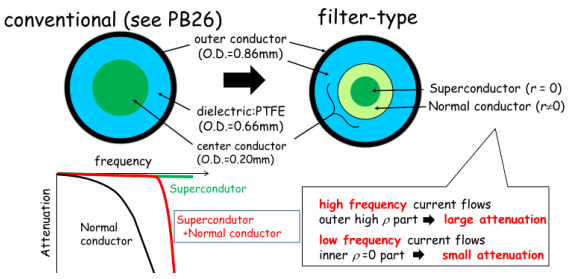
Development of semi-rigid superconducting coaxial cables with normal-conductor-clad center conductor

PB-14

Akihiro Kushino (Kurume University)
Tetsuya Okuyama (National Institute of Technology, Kurume College)
Soichi Kasai (COAX CO.LTD.)

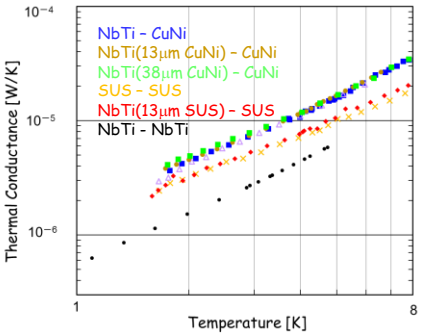
We have developed low-pass-filter-type semi-rigid coaxial cables with an outer diameter of 0.86 mm adopting bilayer structure in the center conductor with a diameter of 0.20 mm. The inner superconductor and surficial normal conductor consist the center conductor. By this configuration, high frequency noise component is expected to attenuate in the normal conductor with high electrical resistivity when it is thicker than the skin depth. We made and evaluated semi-rigid coaxial cable employing superconducting inner NbTi and surficial cupro-nickel (CuNi) or SUS304 clad.

Low-pass-filter type semi-rigid cables



Sample name (center – outer)	Center conductor outer diameter: 0.20mm	Cuter conductor outer diameter: 0.86mm
NbTi (CuNi13) – CuNi	NbTi clad with 13μm thickness of CuNi	CuNi
NbTi (CuNi38) – CuNi	NbTi clad with 38μm thickness of CuNi	CuNi
NbTi (CuNi13) – SUS	NbTi clad with 13μm thickness of SUS	SUS304

Thermal conductance



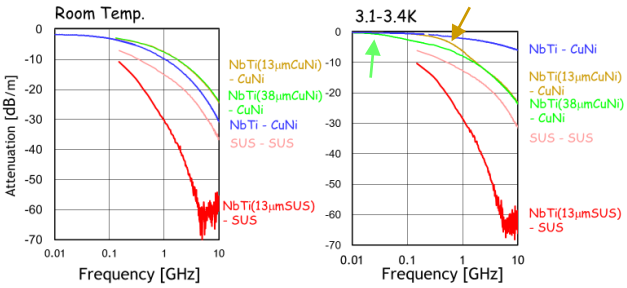
・Thermal conductance of filter-type semi-rigid cables were reasonably low and almost as expected from thermal conductivity of each component.

・Filtering property were observed by cladding of CuNi on the surface of NbTi center superconductors, and cut-off frequency can be changed by the thickness of CuNi.
・Attenuation of semi-rigid cable with SUS/NbTi bilayer in the center conductor was too large and attenuation and cutoff frequency cannot be controlled as seen in CuNi. Martensitic transformation might be induced during drawing treatment of the SUS/NbTi center wire, and observed large attenuation might be caused by the magnetization surrounding the center conductor.

⬇

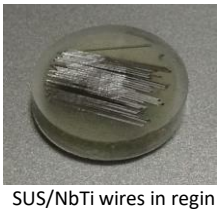
We applied thermal treatment for the center conductor to demagnetize.

High frequency performance of filter cable



Thermal treatment at 1050 degC atmosphere for 1 hour.

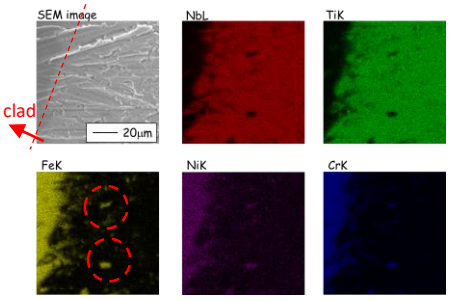
high temperature furnace



SUS/NbTi wires in regin

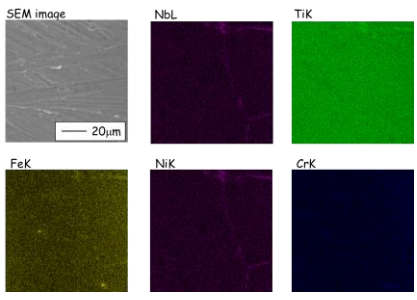
EDS mapping

No thermal treatment



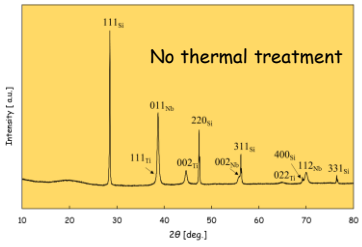
grains caused by SUS304 observed in Nb-Ti inner region.

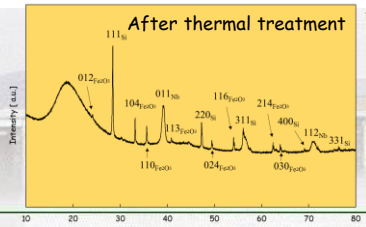
After thermal treatment



Both Nb and Ti decreased, and their intermetallic compound with Fe, Ni, and Cr were increased.

XRD





* Iron oxides were appeared because of atmospheric treatment

Summary

・For filter-type semi-rigid cable with NbTi/SUS center conductor, very large attenuation was observed, which can be caused by the magnetization surrounding the center conductor.
・Iron grains exist in Nb-Ti inner region of center conductor, which might also worsen the high frequency performance of the semi-rigid cable, as observed. This effect will be confirmed by the same observation for NbTi/CuNi center conductor already having filtering property.
・We think thermal treatment reduced magnetization of the NbTi/SUS center conductor, however it may also affect the superconducting property because Nb and Ti disappeared.
・Cooling within shorter time is needed.