Cryogenic Engineering Conference 2015, C1PoK-06, Tucson, AZ, USA (June 28-July 2, 2015)

Mechanical problems for a Ni-alloy reinforced Bi-2223/Ag conductor

-Towards a super-high field and compact size NMR magnet-

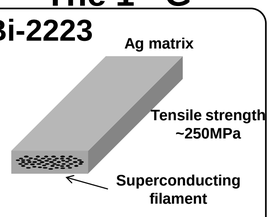
M. Nawa[1,3], Y. Yanagisawa[1,3], H. Nakagome[1], K. Kajita[2,3], T. Takao[2], H. Maeda[3]

[1]Chiba University, [2]Sophia University, [3]RIKEN

High temperature superconductor

The 1st G

Bi-2223

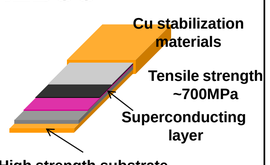


Advantage
Small screening current

Disadvantage
Low tensile strength

The 2nd G

REBCO



Advantage
High tensile strength

Disadvantage
Large screening current

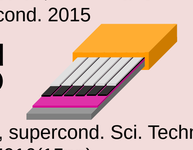
The next G (3rd G)

High strength Bi-2223

Tensile strength ~500MPa

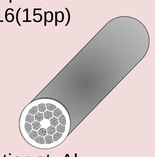
Nakashima et. al., IEEE Trans. Appl. Supercond. 2015

Scribed REBCO



Machi et. al., supercond. Sci. Technol 26(2013)105016(15pp)

Bi-2212



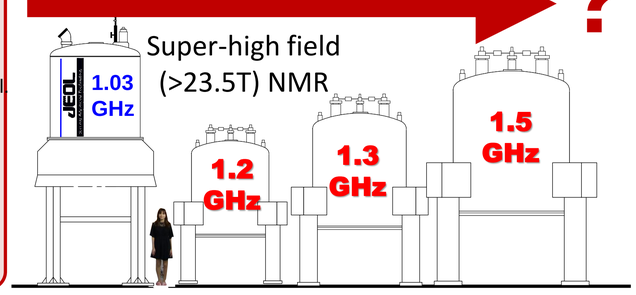
D. C. Larbalestier et. Al Nat. Mat. 13 1-7

The mechanical problem of the high strength Bi-2223

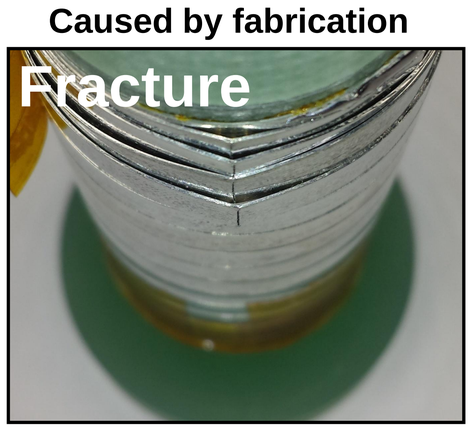
The 1st G → Wall of growth in magnet size

The 2nd G → Wall of magnetic field inhomogenity

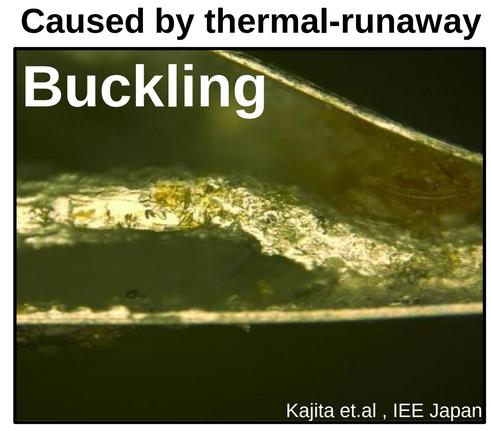
The 3rd G has the possibility → ?



Caused by fabrication

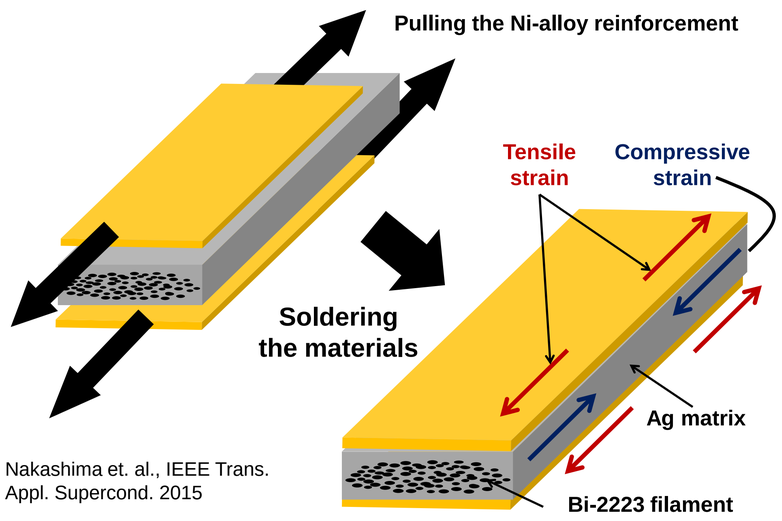


Caused by thermal-runaway



It becomes severe damage if it causes in the high current density driving

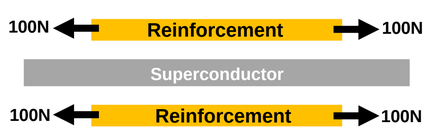
Origin of the fracture



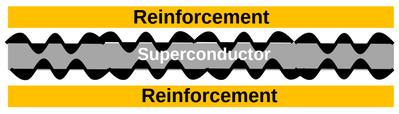
Nakashima et. al., IEEE Trans. Appl. Supercond. 2015

What happens if a part of the conductor becomes high temperature?

1. Pulling the reinforcement



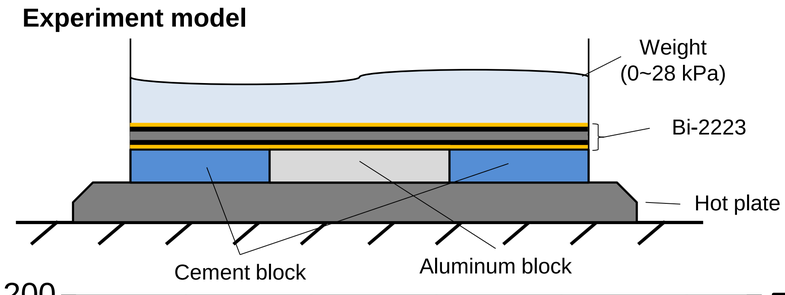
2. Soldering between materials



3. Completion high strength Bi-2223

Experiment to prevent the fracture

Experiment model

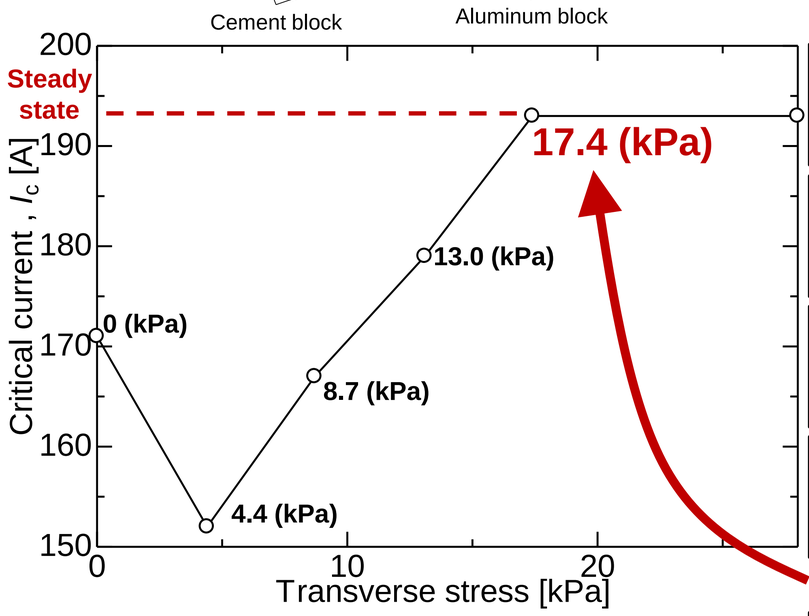


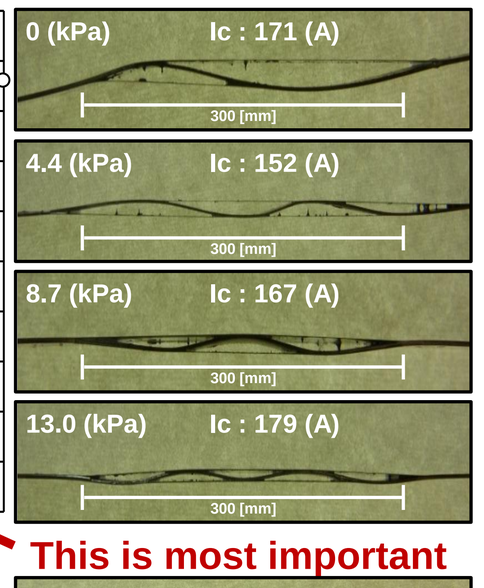
▪Experimental procedure

High strength BI-2223 wire was heated up to 580K with the load.

▪Measurement signal

The critical current value after heating

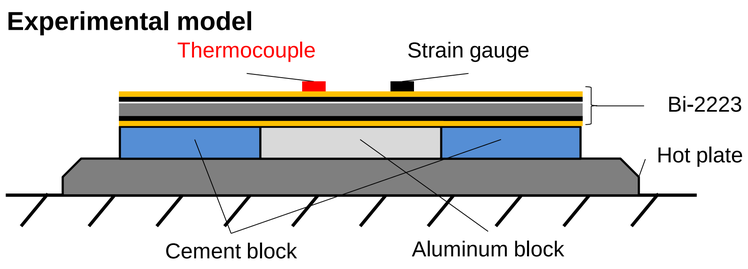




The buckling can be prevented by a low transverse compressive stress

Experiment to clarify the mechanism of the fracture

Experimental model

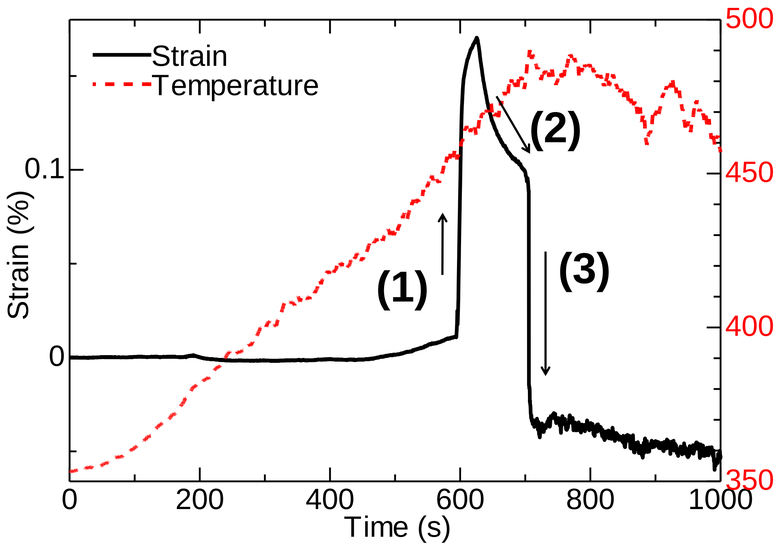


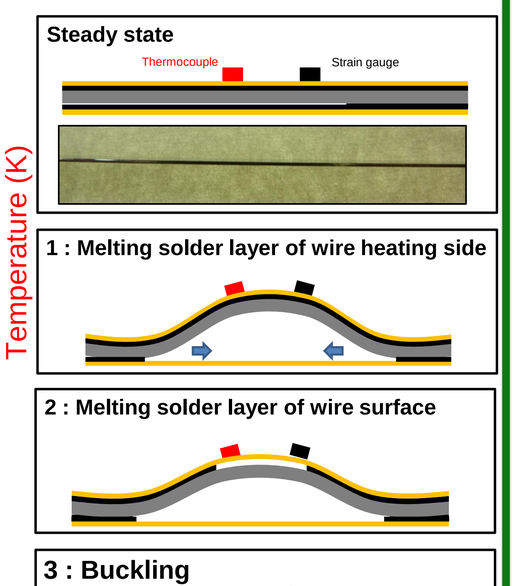
▪Experimental procedure

High strength Bi-2223 wire was heated up to 580K

▪Measured signal

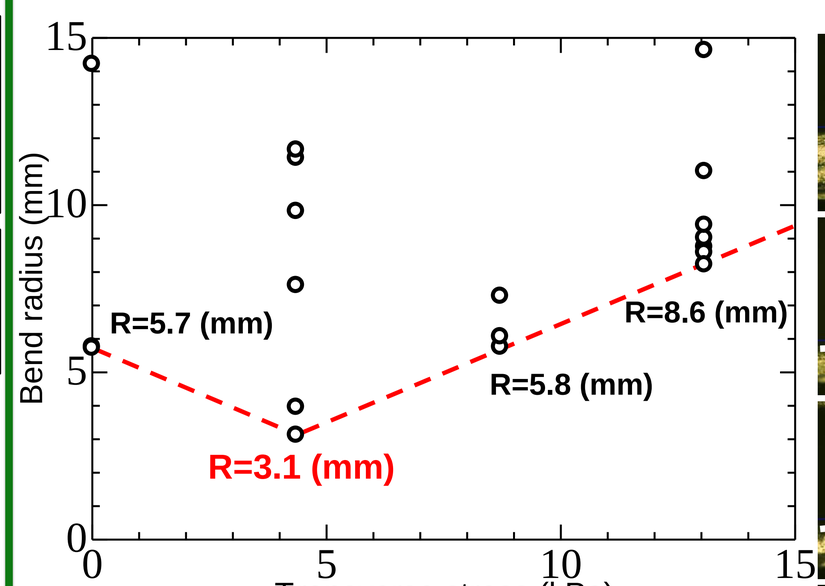
1. Strain 2. Temperature

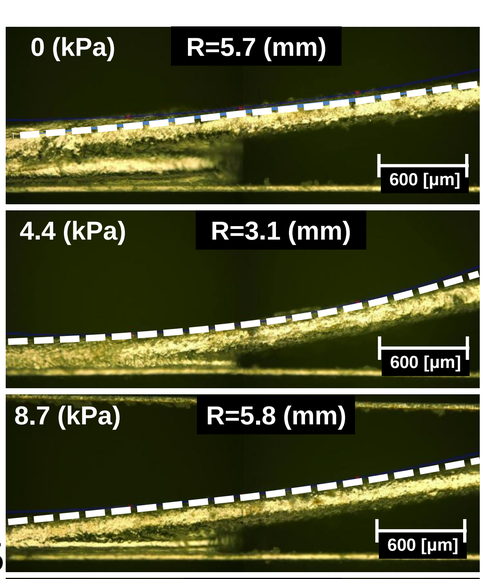




The composite conductor was buckled caused by the release of the internal strains

What dominates the reduction of the critical current?





Bend radius dominates the reduction of critical current

How to prevent the buckling?

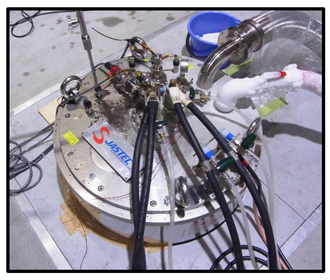
1. Winding tension

Prevent the buckling with winding tension in the coils?

Coil parameter		
Coil id	mm	80.30
coil od	mm	123.66
Number of layer	-	58
Sectional area of conductor	mm	1.33 (4.3 x 0.31)
Current command value	A	305
Backup magnetic field	T	21.5

Winding tension is

High strength Bi-2223 coil



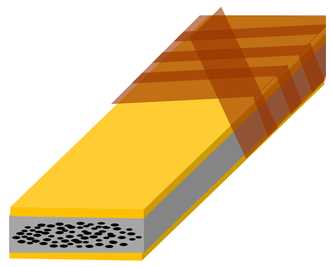
HTS coil for Back up

2. Polyimde electrodeposition

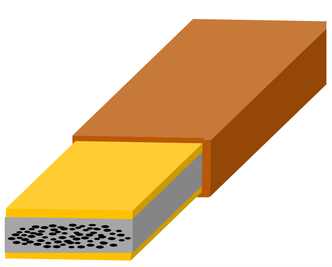
Half lap method get loose easily

Polyimde electrodeposition method Does not get easily because of consolidating

So far : Half rap



Now : Electrodeposition



Conclusion

1. The high strength Bi-2223 conductor is buckled by the release of the internal strain due to temperature rising.
2. A low transverse compressive stress can prevent the buckling.
3. Methods to prevent the buckling in a coil is being investigating.