Thu-Mo-Or32-01

Measurement of persistent current Gd123 coil for superconducting joint fabricated by CJMB method

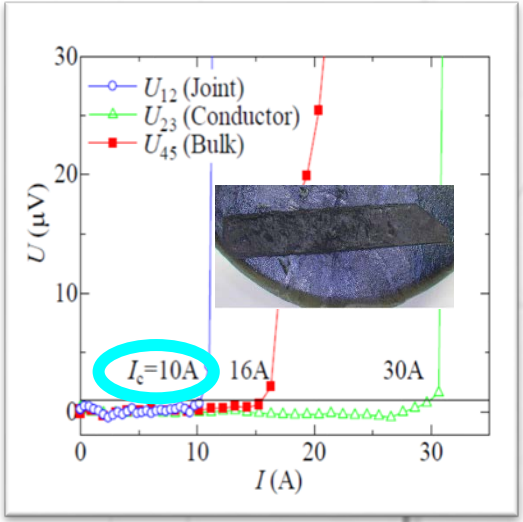
Xinzhe Jin[1,2], Yoshinori Yanagisawa[2], Hideaki Maeda[2]

[1]Muroran Institute of Technology; [2]RIKEN

1. Introduction

Recently, we suggested a new bridge-type joint between two REBCO coated conductors using YBCO bulk by heat treatment with crystal growth at boundary of wire-bulk. We call this method as crystalline joint by melted bulk (**CJMB**).

A model experiment [1] for the joint boundary between the coated conductor and the YBCO bulk (wire-bulk) has been carried out as first step, and it is obtained that the interface has a critical current of 10 A with a high tensile strength above 100 MPa, indicating the feasibility of the practical superconducting joint.



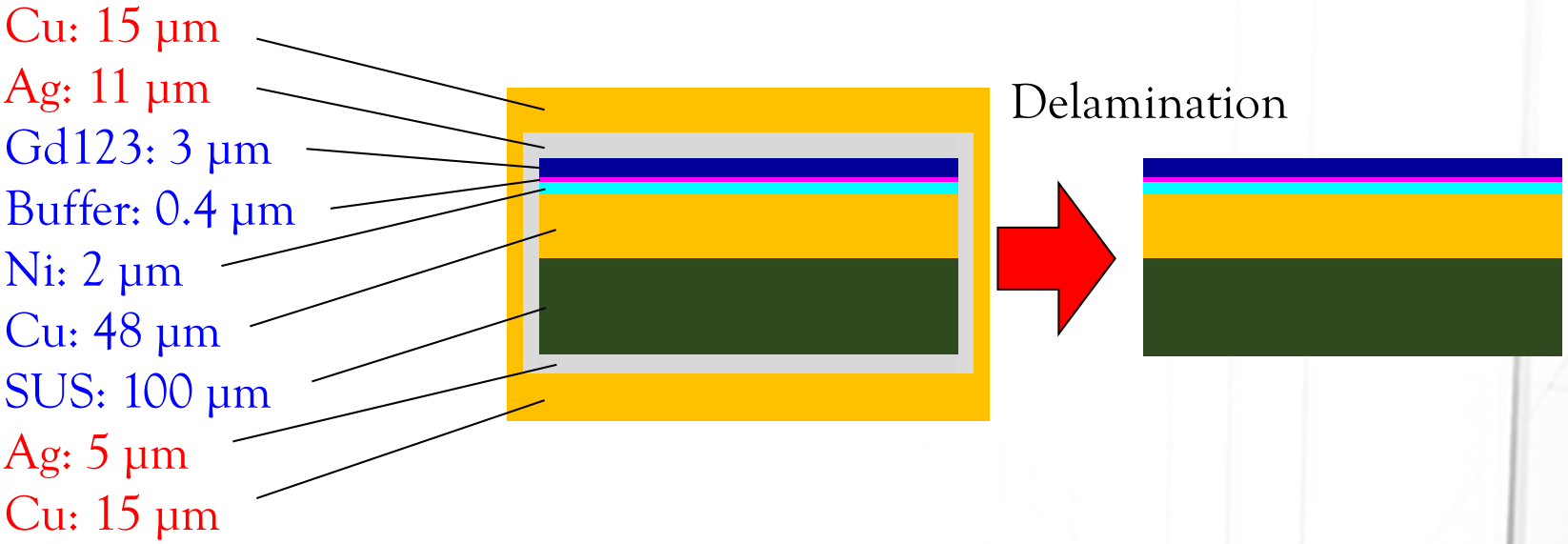
[1] Xinzhe Jin *et al* 2015 *Supercond. Sci. Technol.* **28** 075010

In this study:

We investigated to develop superconducting joint between GdBCO coated conductors using YbBCO bulk intermedium (wire-bulk-wire) during a short preparation time below one day.

2. Wire and bulk

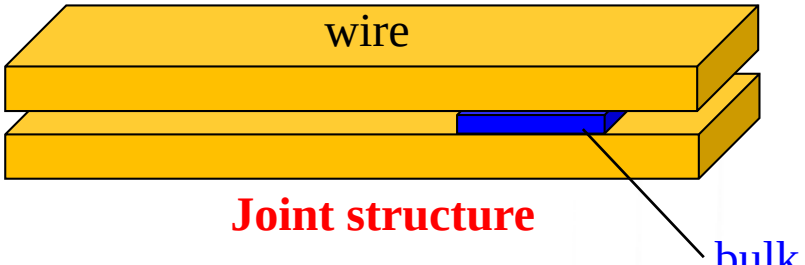
Gd123 coated conductor manufactured by Sumitomo Electric Industries, Ltd



YbBCO bulk

A 3 mm thick piece of Yb123 polycrystalline bulk was prepared by a conventional sintering method using raw materials of Yb_2O_3, $BaCO_3$, and CuO powders, with two 10 h periods of heating at 890 ºC. And then, the YbBCO bulk was ground to a thickness of 0.05~0.1 mm to obtain a Yb123 lamina.

3. Joint method using a YbBCO bulk



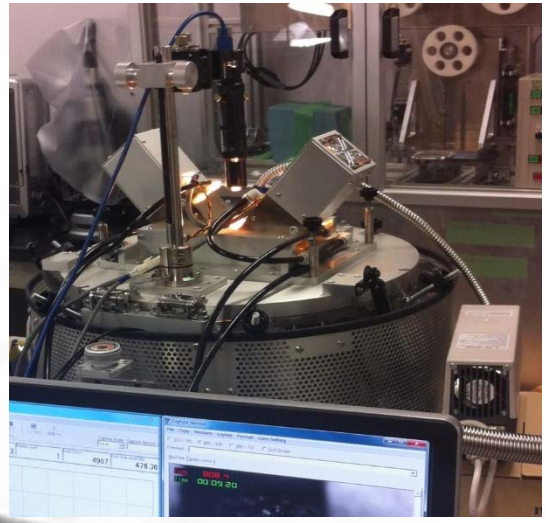
Joint structure

Characteristics

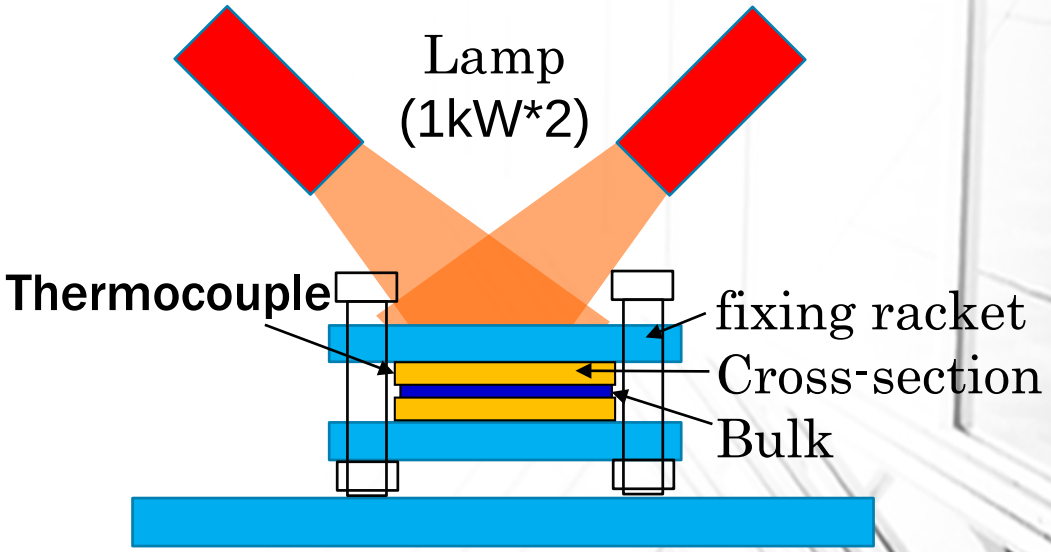
- Using a YbBCO bulk

  $T_{M\text{-}YbBCO}$ = 930 ºC < $T_{M\text{-}GdBCO}$ = 1050 ºC (in air)

- Highest temperature **930 ºC for 1min** in 50% of oxygen atmosphere
  (Without melting of GdBCO layer in the conductors)
- Oxygen aneeling at 450 ºC for 20 h 100% of oxygen atmosphere



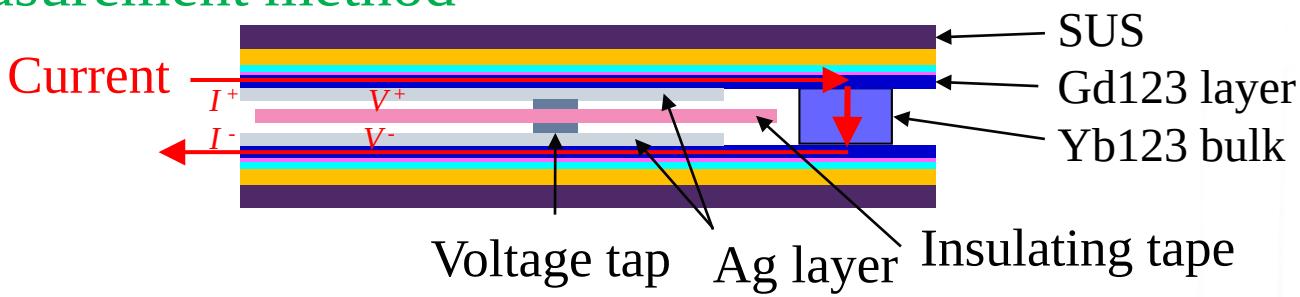
Infrared heater



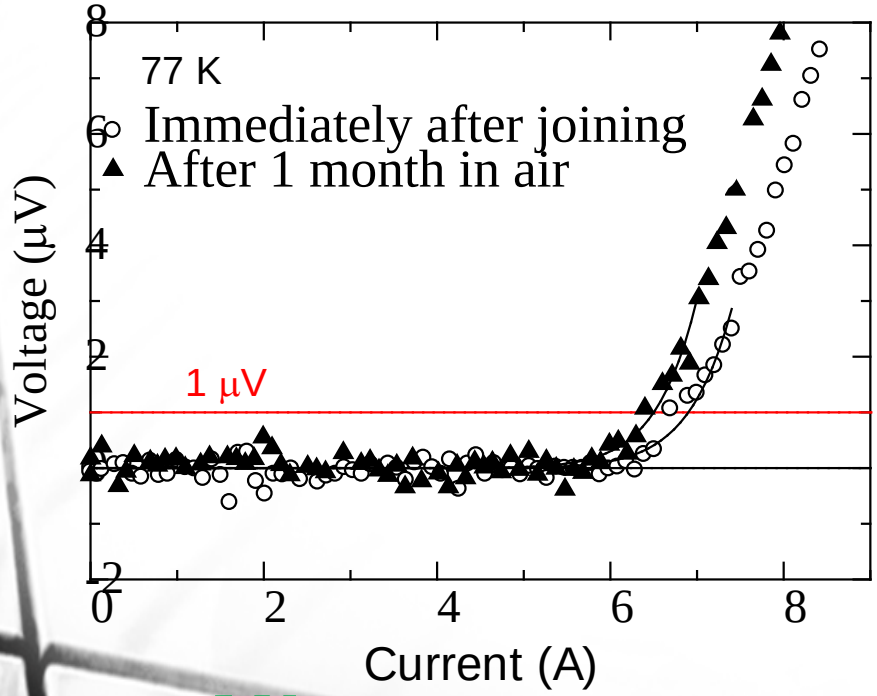
Joint image at cross-section of wire

3. Measurement and result of joint sample

Measurement method



Prepared joint sample



I-V measurement

Superconducting joint by CJMB

Immediately after joining
Critical current I_{c1} = 7 A (n =15)

After 1 month in air
I_{c2} = 6.5 A (93% of I_{c1})

High temporal stability in air

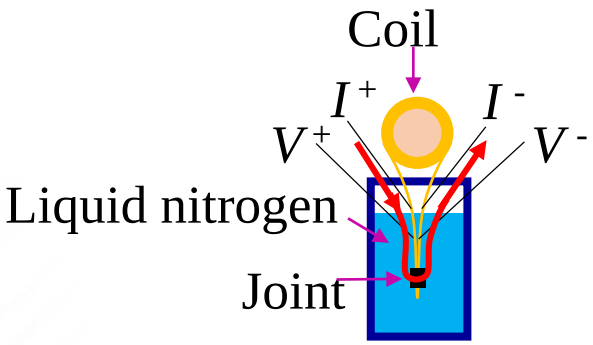
4. Persistent current test in coil sample

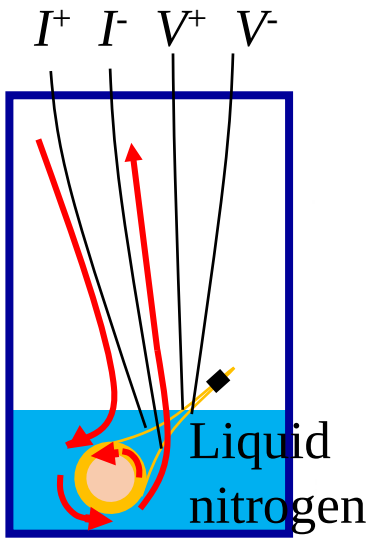
Specification of Coil

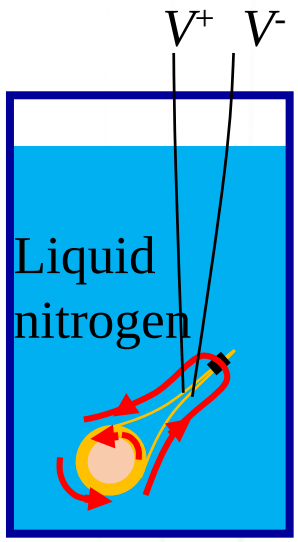
Wire type	Gd123 coated conductor
Critical current of wire at 77 K (A)	220
Length of the wire (m)	7
Winding structure	Double pancake
Inner diameter of coil (mm)	30
Method to isolate	Kapton tape

Coil sample

Measurement method of persistent current without additional persistent current switch (PCS) part





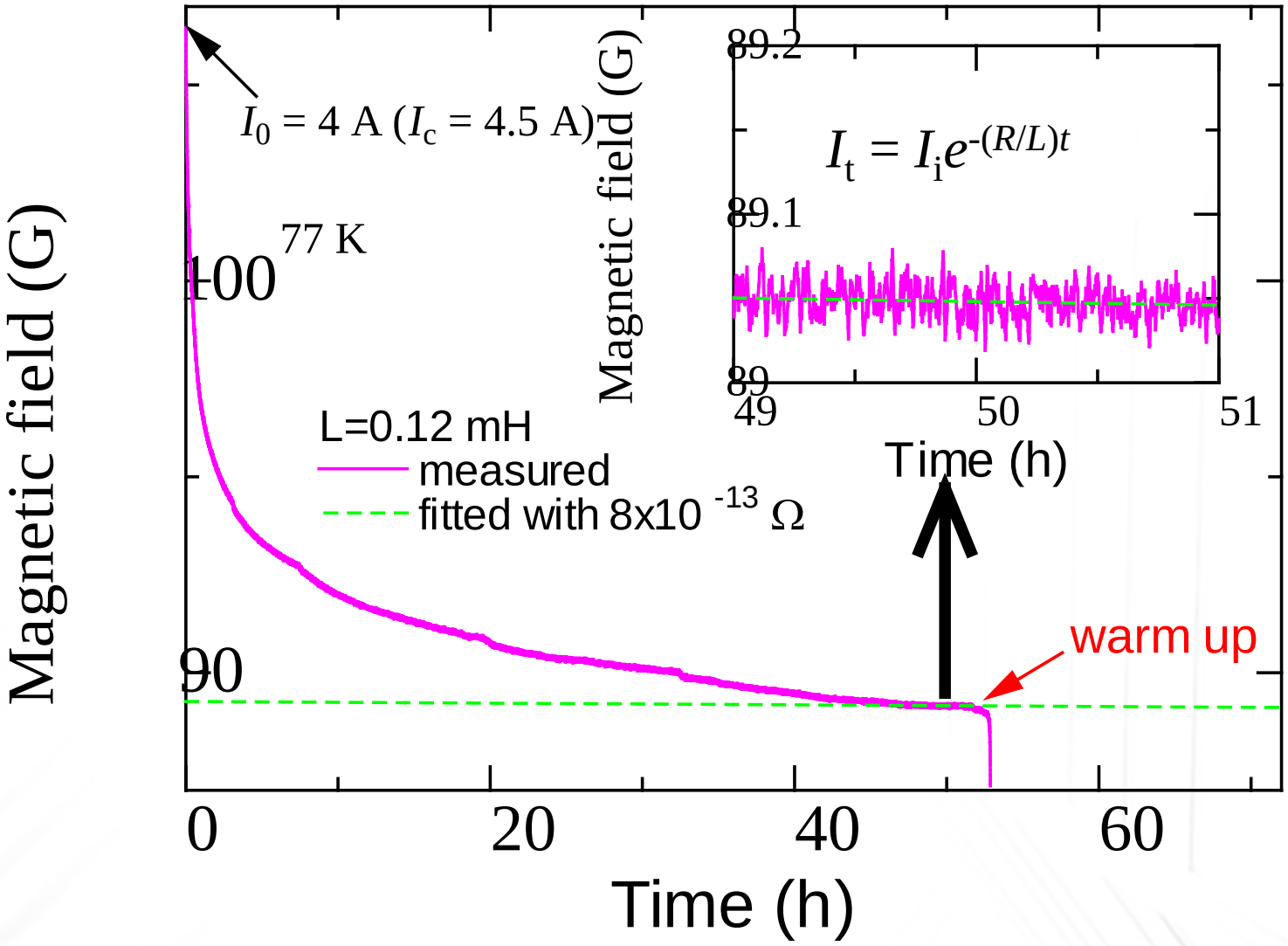


Step1: I_c measurement for joint part in coil sample at temperature 77 K

Step 2: Current supply to the coil without current-carrying to the joint part as PCS function

Step 3: Persistent current measurement after total coil is put into liquid nitrogen

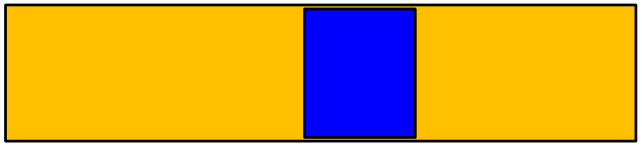
The joint part can be used as a PCS function.



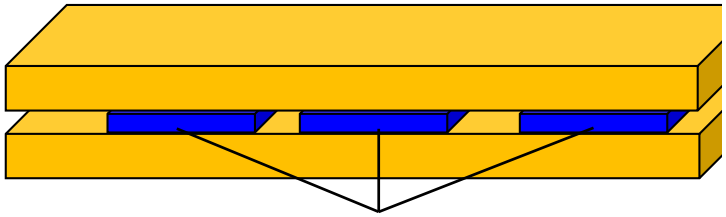
Magnetic field measurement at the coil center

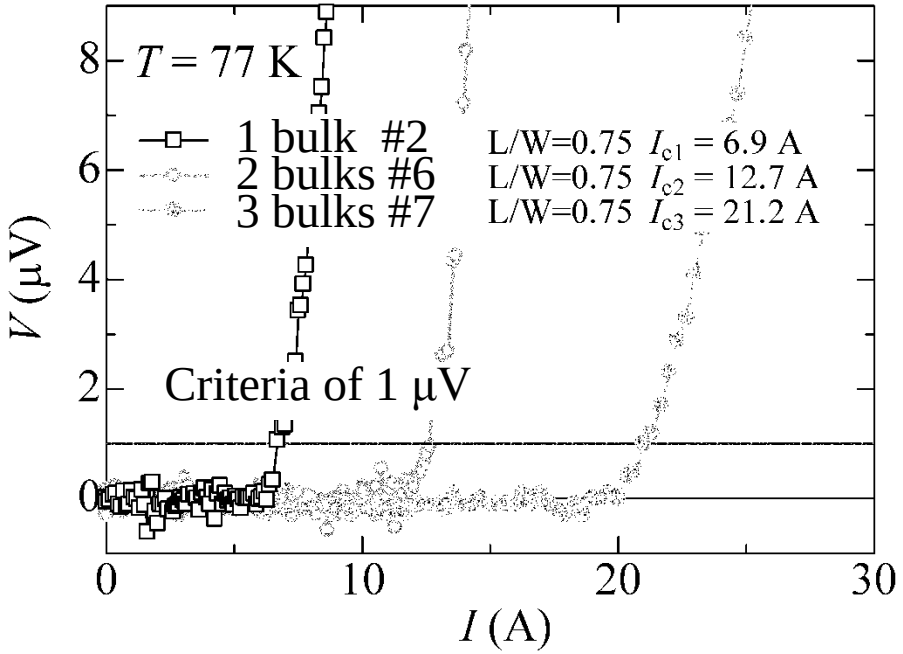
5. Development of joint to increase the I_c

Optimum size of a YbBCO bulk



Multiple intermedia





No.	Bulk number	Length (mm)	Thickness (mm)	Area (mm^2)	I_c (A)
#1	1	12	0.05	36	6.5
#2	1	3	0.05	9	6.9
#3	1	1	0.05	3	1.0
#4	1	3	1	9	0.5
#5	1	3	0.02	9	6.0
#6	2	3	0.05	18	12.7
#7	3	3	0.05	18	21.2

6. Results and next plan

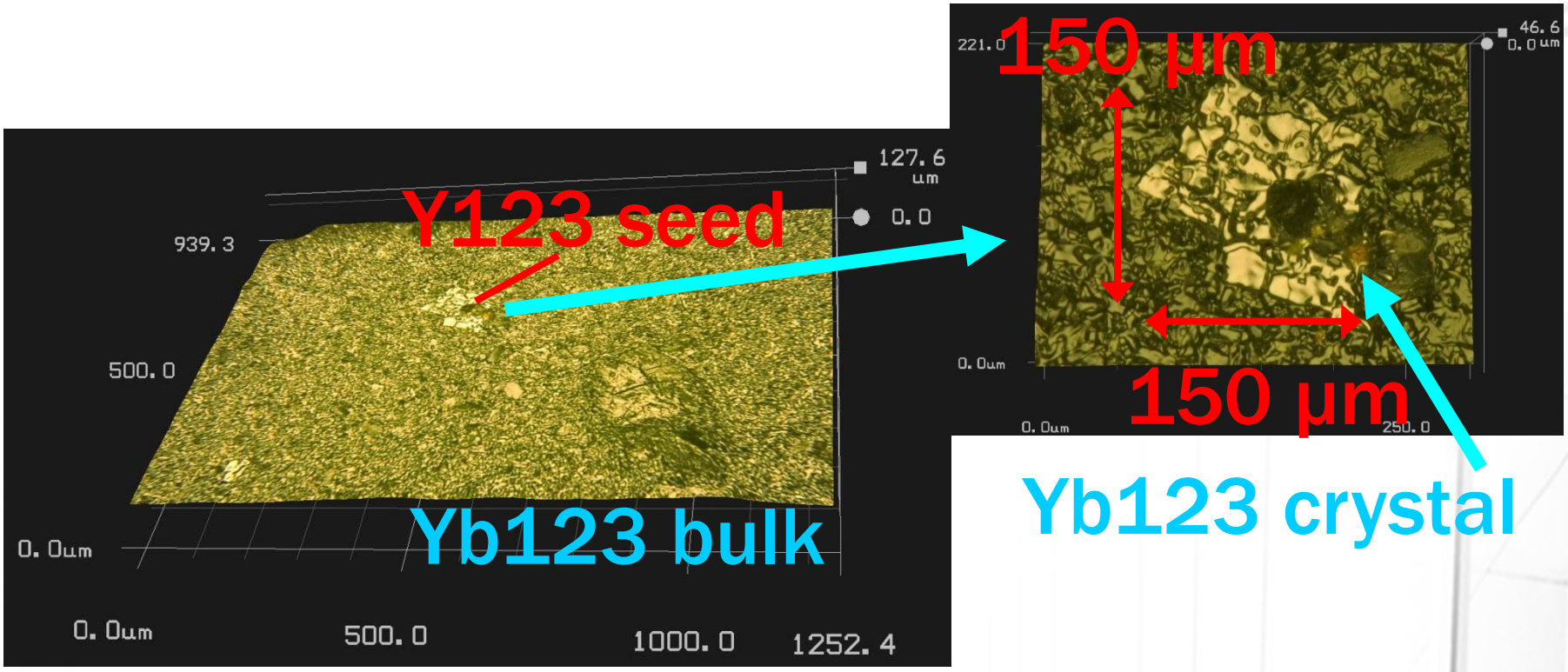
Results:

- A superconducting joint between Gd123 wires was successfully developed with critical current about 21 A at 77 K.
- A high temporal stability of the critical current in air was measured for the joint sample fabricated by CJMB method.
- Persistent current coil of the Gd123 coated conductor has a low resistance below 1 pΩ (10^{-12} Ω), that is applicable in NMR magnet.

Next plans:

- R&D for 50 A of critical current at 77K
- Observation of boundary using SEM

Investigate of crystal growth of YbBCO



A **low growth speed**: ~ 150 μm width for 2 days

In joint: crystal growth below 1 μm at boundary

Gd123 layer of the coated conductor

Poly crystal in bulk center

Crystal growth at boundary

Gd123 layer of the coated conductor