

rectangular Rod (0.5 × 0.5 × 10 mm³)

sharp Rod (Tip ~100 μm)

2 Polishing machin

超伝導体が拓く走査プローブ顕微技術の新展開

Scanning probe microscope (SPM)

Piezoelectri

devices

(This m (I) Tunnel curren

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SPM is a term for microscopes based on a scanning tunneling microscope (STM).

Gap

Bias

An STM equipped with an HTS probe is expected to realize SIS junction

that are separated by a vacuum insulator

XY drive circuit

Tunnel current

detection circuit

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Z-voltage feedback

§1 Introduction



§ 2 Rod development



<u>§ 3 Probe development</u>

(a) Rod polishing



(b) Probe fabrication			(c) I Analysis of infl Energy dispersive X-ray spectr	
Aperture diameter	550 µm		Counting rate	~3 kcm
Beam current	56 nA	~ 1.0 µm	Acceleration voltage	30 kV
density	Full	20 um	Acceleration voltage	100.12
width	1 pixel	20 pm	Measurement time	100~12
Irradiation time	20 min		Working distance	$15 \pm 0.$
	1-0	Sharp YBCO probe was processed by FIB.	Magnification	×10k

luence of Ga-ion implantation oscopy in FE-SEM (EMAX ENERGY EX-250, Horiba) ated YBCO probe ▲B Ja/Y | •A C

(c) Probe evaluation

Overview of the fabrication flow

T Fine cutter

machine

③ Focused ion beam

(FIB)

Rod development $(\rightarrow \S 2)$

Probe development $(\rightarrow \underline{\S3})$ Probe (Tip~1 µm)

c-axis Bulk (40 × 40 × 10 mm³)



§ 4 Installation to SPM (AFM mode)





§ 5 Summary

We proposed, fabricated, and evaluated a YBCO probe for realizing SIS junctions Rod development

- > A c-axis oriented bulk was cut into a rectangular rod using a fine cutter machine
- $T_{\rm c}$ of the rod was ~90 K, which was almost the same as that of the original bulk, indicating no critical damage to superconductivity owing to the cutting.
- Probe development
- > One end of the rod was ground to a pyramid shape of ~70 μ m radius, and then the apex was further sharpened to ~1 μ m using a focused Ga ion beam.
- The penetration depth of Ga ions from the YBCO surface was <1 µm at 40 kV, suggesting that the chemical composition was conserved inside the rod.</p> Installation to SPM (AFM mode)
- > A YBCO probe was installed in an AFM system, where the probe temperature was set at 300 K at the time. Depending on the tip radius, a clear AFM image was obtained by gluing the probe to a quartz-tuning fork.
- Future works
- ➢ Optimization of FIB process → Sharper probe tip, reduced Ga-ion damage
- ➤ Construction of 77 K-cooled AFM → AFM image in liquid nitrogen
- ➢ Construction of STM → YBCO-based SIS nano-junctions

the probe to the tuning fork 技術を究め、技術を創る

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