

# 超伝導体が拓く走査プローブ顕微技術の新展開

プロジェクトメンバー: 次世代半導体・センサ科学研究所 大西 漢、田口 竜一、林 幹二、田中 三郎、有吉 誠一郎

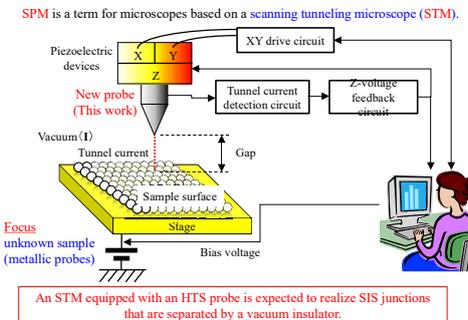
9 産業と技術革新の基盤をつくろう

## § 1 Introduction

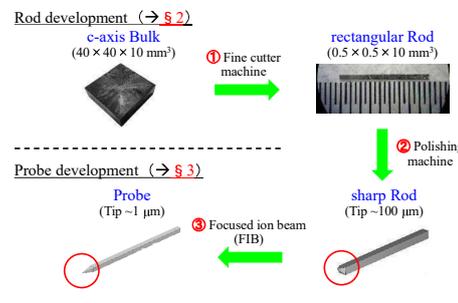
### Comparison of superconducting tunnel junctions (STJs)

Low Temp. Supercond. (LTS)	High Temp. Supercond. (HTS)
<ul style="list-style-type: none"> <li>S-I-S junctions are realized.</li> <li>Extremely low noise (at 4 K)</li> </ul>	<ul style="list-style-type: none"> <li>S-I-S junctions are not realized.</li> <li>Modest noise (at 77 K)</li> </ul>
<ul style="list-style-type: none"> <li>Applications</li> <li>Sensors</li> <li>Generators</li> <li>Quantum computers etc.</li> </ul>	<ul style="list-style-type: none"> <li>Our purpose</li> <li>To maximize the potential of HTS electronics by SIS nano-junctions</li> </ul>

### Scanning probe microscope (SPM)

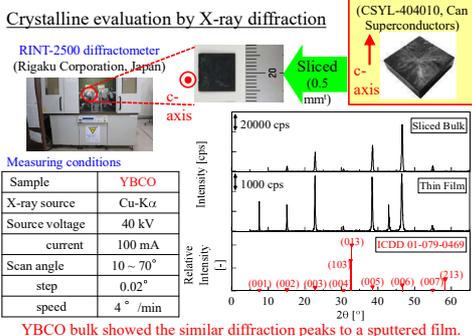


### Overview of the fabrication flow

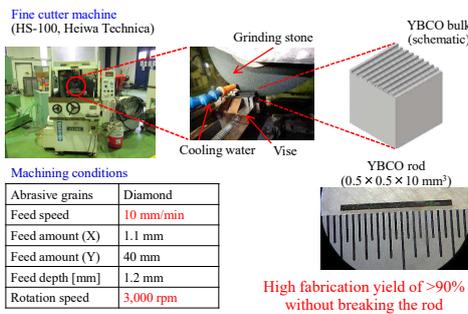


## § 2 Rod development

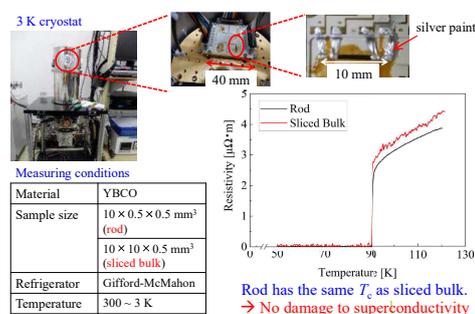
### (a) Bulk evaluation



### (b) Rod fabrication

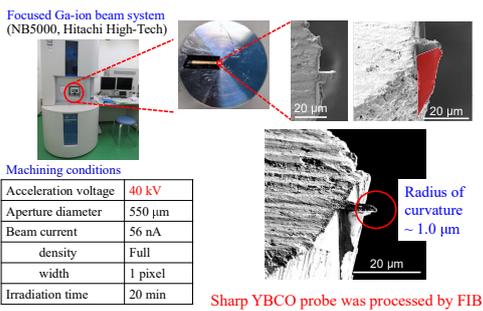


### (c) Rod evaluation

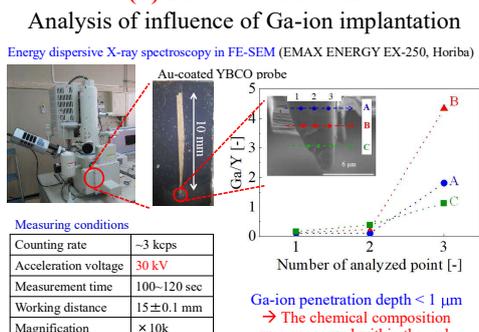


## § 3 Probe development

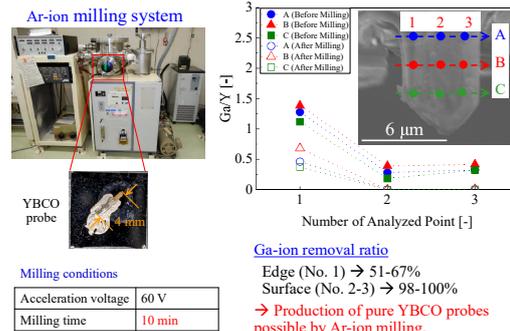
### (a) Probe fabrication



### (b) Probe evaluation

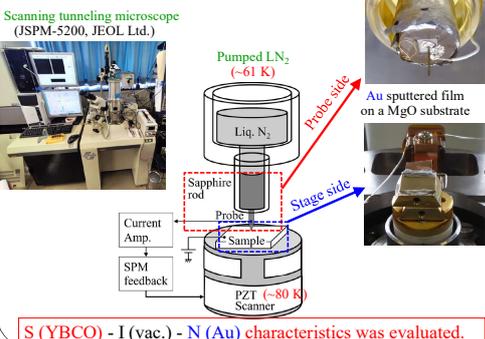


### (c) Probe cleaning

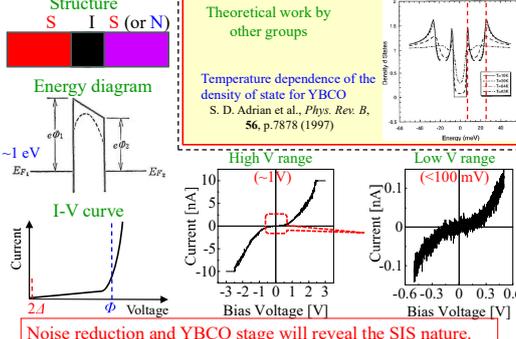


## § 4 Installation to SPM (STM mode)

### Experimental setup



### Tunnel current characteristics



## § 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.
  - $T_c$  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 μm radius, and then the apex was further sharpened to ~1 μm 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.
- Installation to SPM (STM mode)**
  - A YBCO probe was installed in a LN<sub>2</sub>-cooled STM system. Preliminary results about the tunnel current characteristics were obtained. A sharp increase in tunnel current from ~1 V was observed at the high V range, and SIS-like I-V curve was also acquired at the low V range.
- Future works**
  - Optimization of FIB process → Sharper probe tip, reduced Ga-ion damage
  - Atomic force microscope imaging in liquid nitrogen
  - Noise reduction in STM → YBCO-based SIS nano-junctions

連絡先  
ariyoshi@tut.jp

技術を究め、技術を創る  
国立大学法人 豊橋技術科学大学

