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Magnetic Microscopy for Nondestructive Characterization of Local Critical Current Distribution in Multi-filamentary MgB_2 Wires with Magnetic Sheath Materials

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1. Introduction

For further performance improvement of MgB_2 round wire, it is necessary to investigate the relationship between local I_c distribution and microstructure.

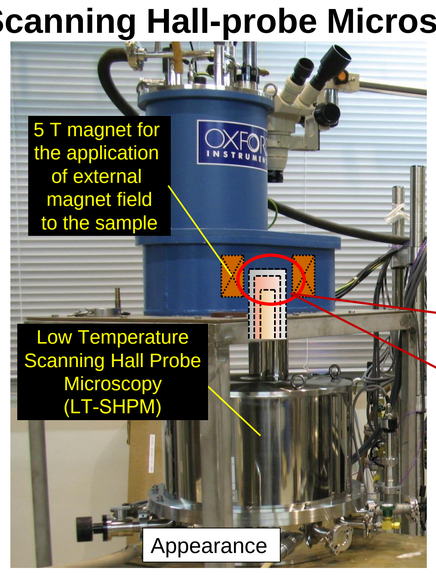
Furthermore, most of commercial MgB_2 wires have **magnetic materials** and consist of **several MgB_2 filaments.**

In our previous study, by applying external magnetic field over saturation field of magnetic materials, we succeeded in characterizing local critical current distribution in **mono**-filamentary wires by scanning Hall-probe microscopy (SHPM) in a nondestructive manner.

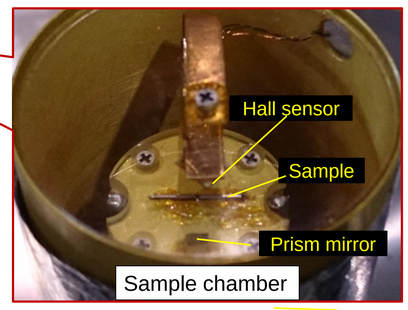
In this study, we extended our method to **multi-filamentary** wires for **nondestructive** characterizing local critical current distribution.

2. Scanning Hall Probe Microscopy

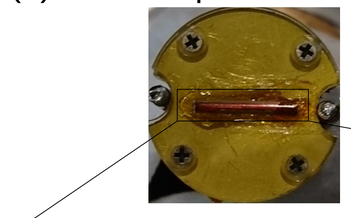
In-field Scanning Hall-probe Microscopy(SHPM)



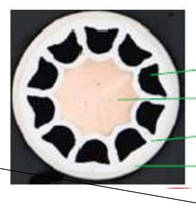
External magnetic field	0-5 T
Stage temperature	5-100 K
Scanning area	10 x 10 mm²
Scanning resolution	0.5 ×0.5×0.25 μm
Active area of Hall sensor:	50 x 50 μm²



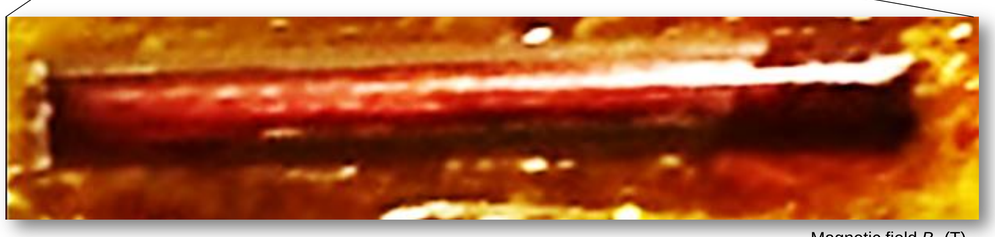
(a) The sample set on SHPM



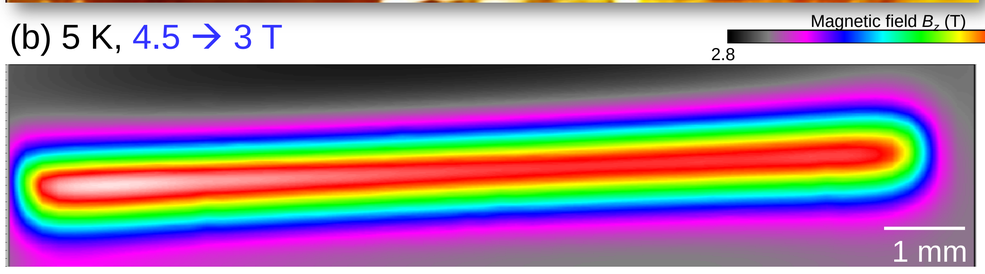
Sectional view of the sample



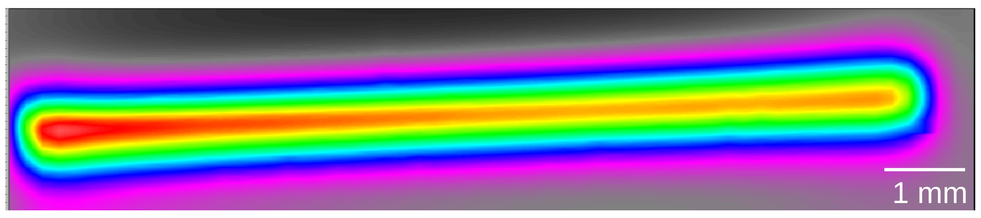
Diameter 1.5 mm
MgB_2
Oxygen-free Cu
Pure Fe
Monel



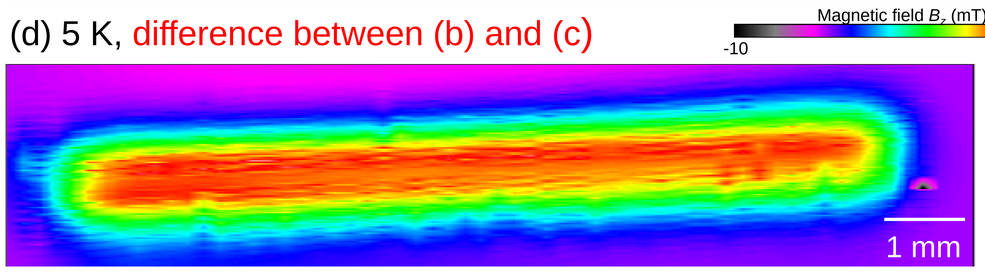
(b) 5 K, 4.5 → 3 T



(c) 5 K, 0 → 3 T



(d) 5 K, difference between (b) and (c)

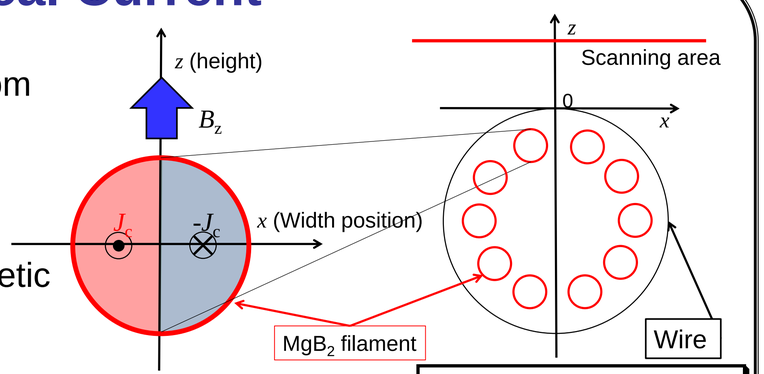


Local magnetic field distribution from only MgB_2 filaments in nondestructive procedure

3. Analysis of Critical Current

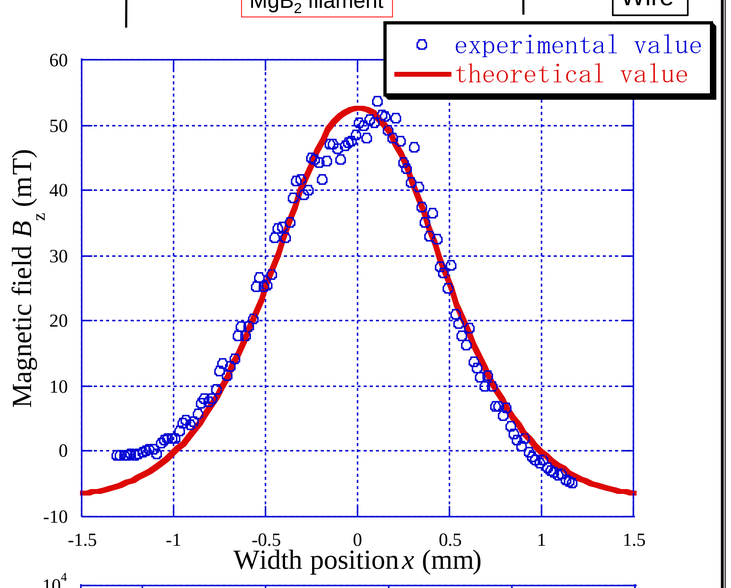
We compared magnetic field from SHPM and theoretical ones for estimating critical current

We calculated theoretical magnetic field under the simple current situation such as right figure



By curve fitting, we could estimate I_c value of the sample wire is **2850 A** at 5 K, 3 T

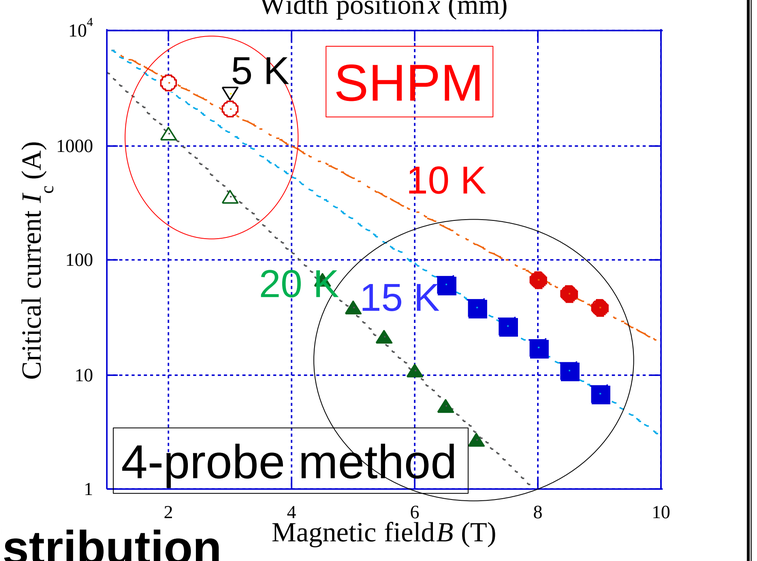
In the same way, we obtained I_c values at several situations



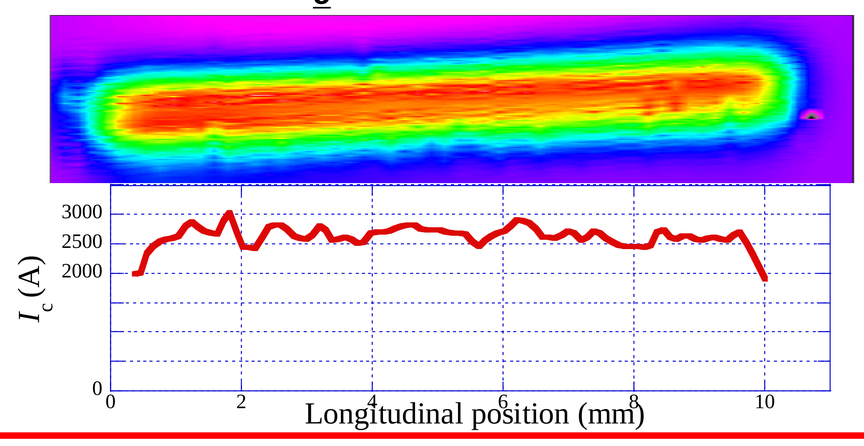
$I_c(B)$ Properties

To compare between SHPM and 4-probe method in the magnetic field **2 T and 3 T** quantitative I_c values were confirmed

These results are helpful for obtaining data in important conditions where I_c becomes too high to measure by 4-probe method



Longitudinal local I_c distribution



Success in estimating local I_c distribution of multi-filamentary MgB_2 wire

4. Conclusion

We succeeded in characterize local critical current distribution in multi-filamentary wires by SHPM in a nondestructive manner

Furthermore, we could estimate critical currents under important conditions where they become too high to estimate by the four-probe method

This nondestructive method will be important for improvement of commercial Multi-filamentary MgB_2 wires

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