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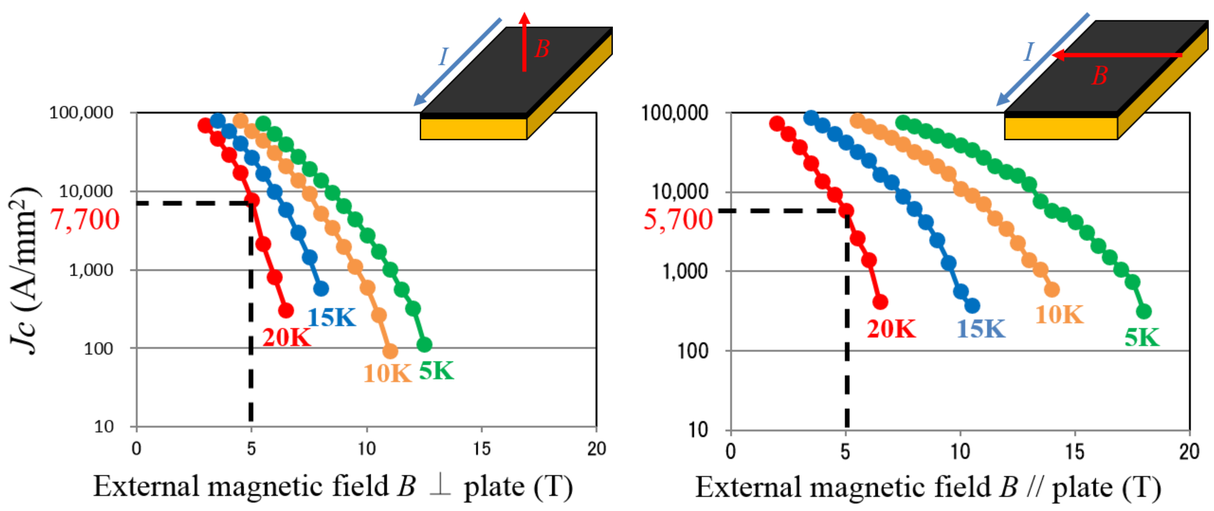
Jc-B-T properties of MgB_2 film on Cu tape

Takumu IWANAKA[1], Toshiaki KUSUNOKI[1], Akiyoshi Matsumoto[2], Shigeru HORII[3], Toshiya DOI[3]

[1] Research & Development Group, Hitachi, Ltd. [2] Superconducting Wire Unit, National Institute for Material Science, [3] Graduate School , of Energy Science, Kyoto University

1. Motivation

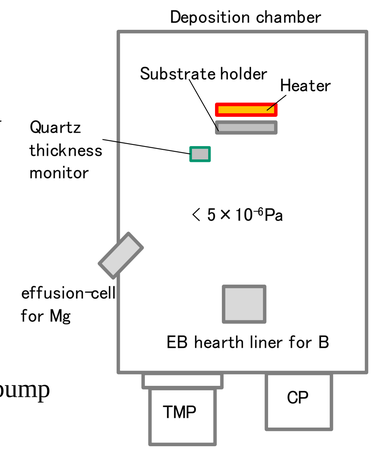
Last year, we reported MgB_2 film deposited on 500 μm-thick Cu plate [1]. The superior *Jc-B-T* properties of the film suggested that thin film MgB_2 will be advantageous for superconductor tape and coil applications under high magnetic field. The next step is depositing MgB_2 film on thin Cu tape to increase the engineering critical current density *Je*. We deposited MgB_2 film on 40 μm-thick Cu tape and measured *Tc*, *Jc-B-T* and *Je-B-T* properties.



***Jc-B-T* properties of MgB_2 film on Cu plate [1]**

2. Experimental method

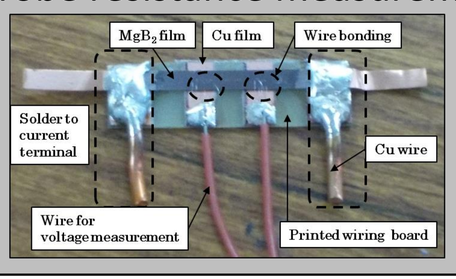
MgB_2 films were deposited by co-evaporation of boron and magnesium. B was evaporated by EB, while Mg was evaporated by effusion cell.



EB: Electron beam
TMP: Turbo molecular pump
CP: Cryo-pump

3. Evaluation method

Critical current density : 4-probe resistance measurement



Magnetic susceptibility : SQUID flux meter

Cross-section structure : TEM and STEM

Surface structure : SEM

4. Results

■ Tc of MgB_2 film was almost same on Cu tape and plate. Crystal orientation of film on tape got worse than plate.

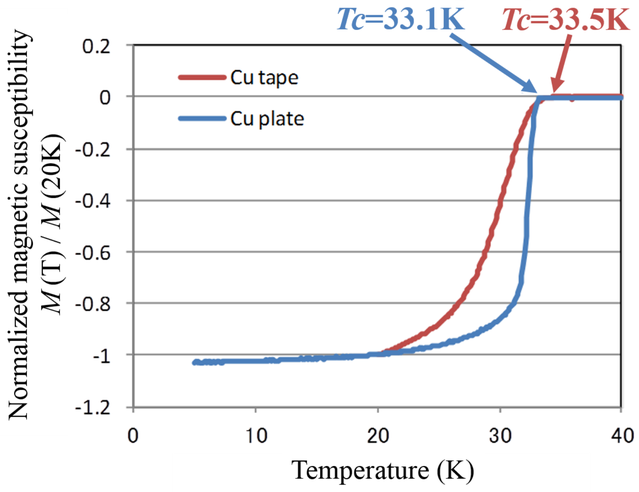


Fig.1 Magnetization curve

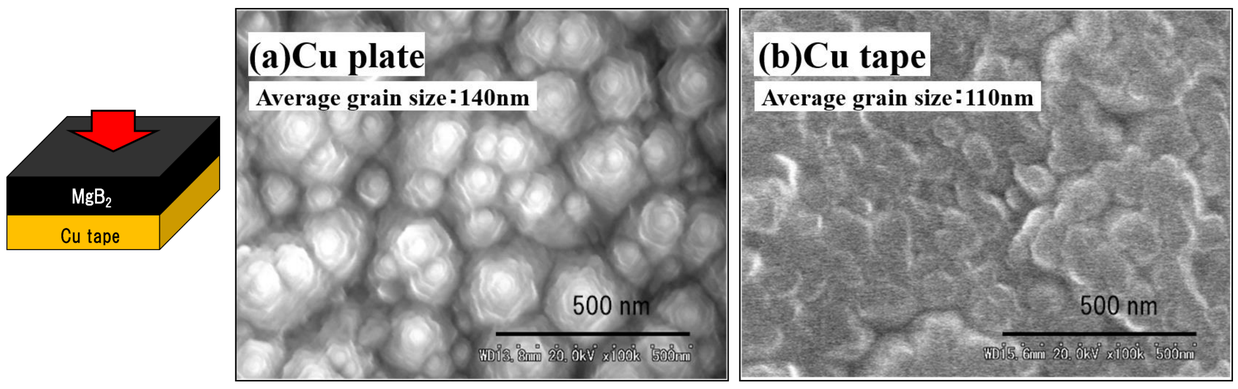


Fig.2 Surface SEM images of MgB_2 films on (a)Cu plate and (b)Cu tape

■ *Jc* of films on Cu plate and tape

- *B* ⊥ substrate plate : 7,700 → tape : 1,4000 A/mm² @ 20 K, 5 T
- *B* // substrate plate : 5,700 → tape : 2,200 A/mm² @ 20 K, 5 T

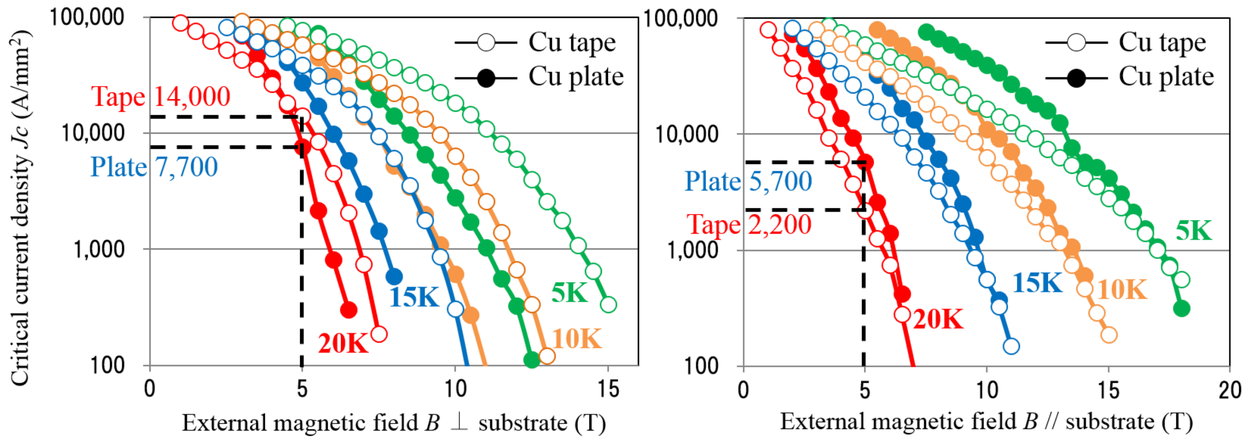


Fig.3 *Jc-B-T* properties

■ *Je* of films on Cu plate and tape

- The thickness of substrate plate : 500 μm → tape : 40 μm
- *B* ⊥ substrate plate : 150 → tape : 2,950 A/mm² @ 20 K, 5 T
- *B* // substrate plate : 110 → tape : 460 A/mm² @ 20 K, 5 T

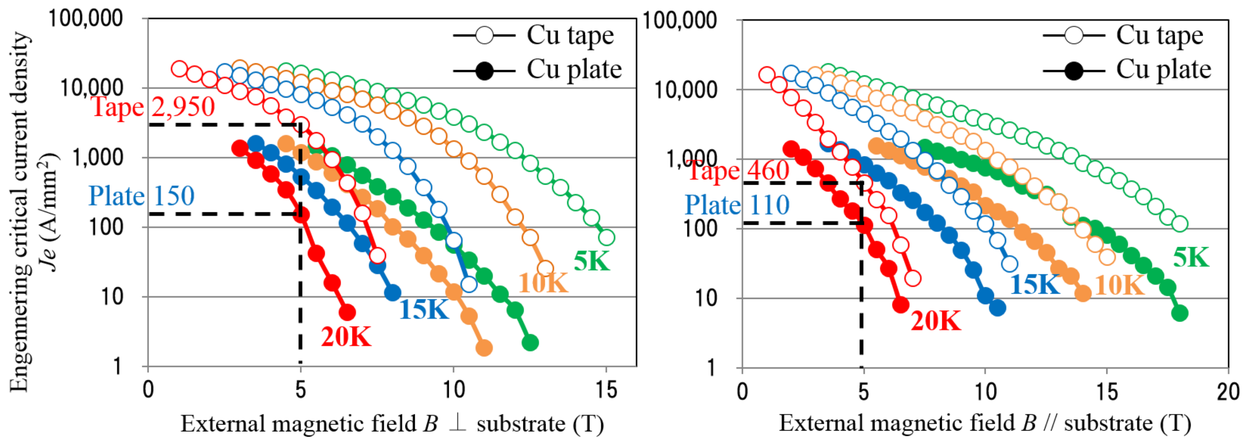


Fig.4 *Je-B-T* properties

■ MgO_x are distributed at grain boundaries of MgB_2

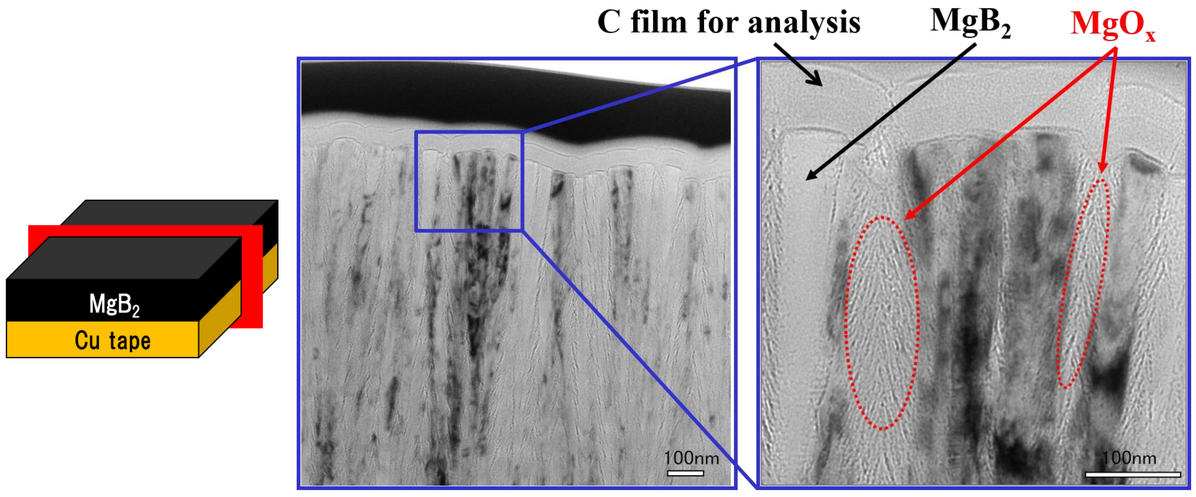


Fig.5 TEM image of cross-section.

■ Cause of *Jc* change

- *B* ⊥ substrate : *Jc* improved
  pinning force improvement
  > crystal orientation degradation
- *B* ⊥ substrate : *Jc* degraded
  pinning force improvement
  < crystal orientation degradation

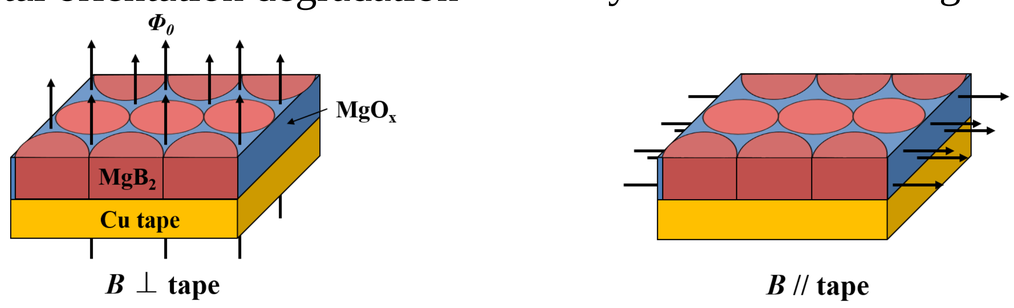


Fig.6 Overview figure of pinning center (MgO_x)

5. Conclusions

We deposited MgB_2 film on thin Cu tape and measured *Tc*, *Jc-B-T* and *Je-B-T* properties.

(1) *Tc* of film on tape was 33.5 K, equivalent to that of film on plate .

(2) *Je* at 20 K, *B*=5 T was 2,950A/mm² in the *B* ⊥ substrate direction and 460 A/mm² in the *B* // substrate direction.

(3) *Jc* of film on tape at 20 K, 5 T improved in *B* ⊥ substrate direction and degraded in *B* // substrate direction than that of film on plate due to existence of MgO_x.

6. References

[1] T. Kusunoki, et al. ASC 2016, 3MPo2B-10 (Sep.2016 , Denver, USA)