HPCVD of Superconducting MgB_2 Coatings for 3 GHz RF Cavities

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TEMPLE UNIVERSITY

Materials physics of electronic and photonic thin films Lab.

List of Contents

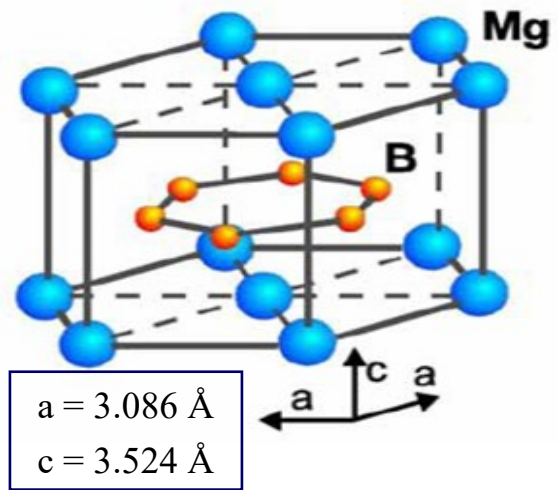
1. Properties of MgB_2

2. Goals and status of research

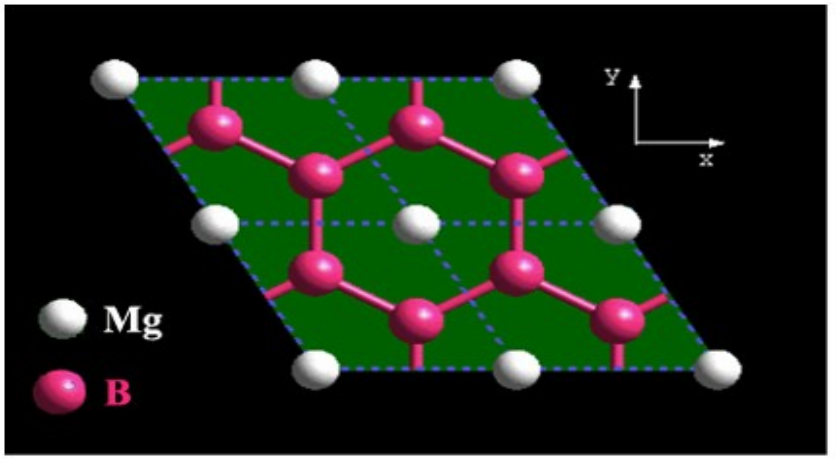
3. Film measurement data of 3 GHz cavity

1. Properties of MgB_2

◈ Basic Properties of MgB_2



a = 3.086 Å
c = 3.524 Å



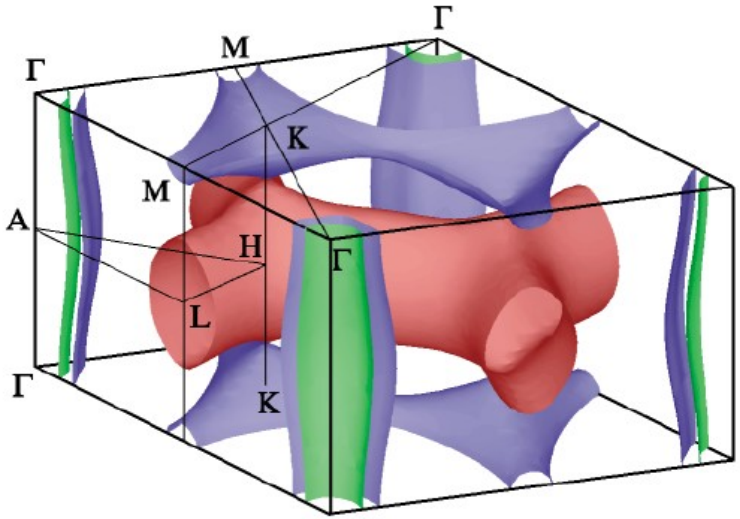


FIG. 3 (color). The Fermi surface of MgB_2. Green and blue cylinders (holelike) come from the bonding $p_{x,y}$ bands, the blue tubular network (holelike) from the bonding p_z bands, and the red (electronlike) tubular network from the antibonding p_z band. The last two surfaces touch at the K point.

Transition Temperature : 39 K

Upper Critical Field at 5 K : 40 T

Critical Current Density at 5 K and in self field :

40 MA/cm^2

(N. I. Medvedeva *et al.* Phys. Rev. B . 64. 020502(2002))

1. Properties of MgB_2

◈ Properties for SRF cavity

- low residual resistance
- non weak link behavior between the grain boundaries

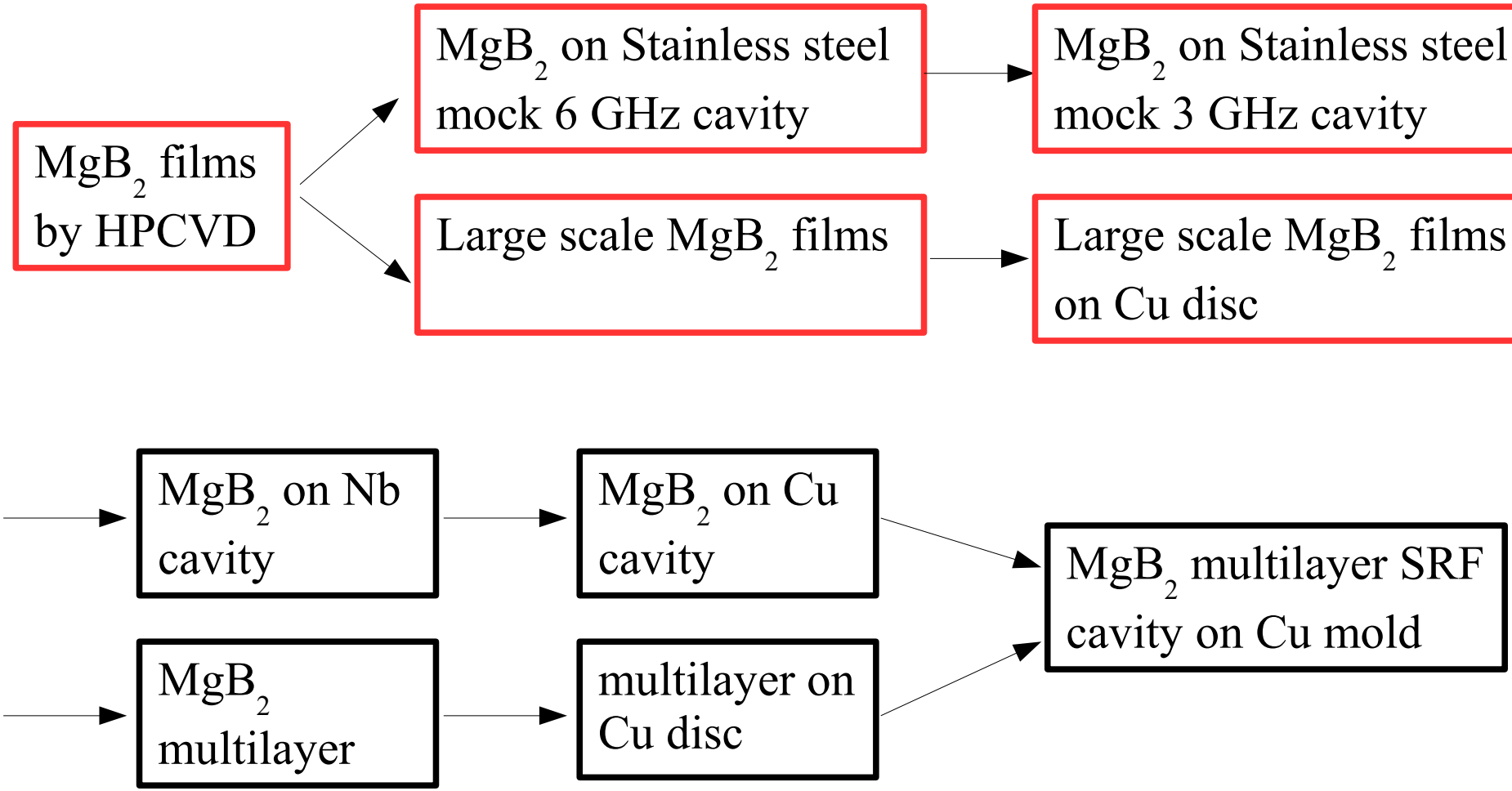
Higher operational temperature
Cheaper compared to bulk Nb cavities with high purity

Table 1: Critical fields for Nb, Nb_3Sn and MgB_2. The superheating field H_{sh} was calculated for Nb from $H_{sh} = 1.2\ H_c$ ($\kappa_{GL} \sim 1$) and for Nb_3Sn and MgB_2 from $H_{sh} = 0.75\ H_c$ ($\kappa_{GL} >> 1$) [4].

Material	T_c [K]	GL Parameter κ_{GL}	H_c [Oe]	H_{c1} [Oe]	H_{c2} [Oe]	H_{sh} [Oe]
Nb (0K)	9.2	0.78	2000	1700	2400	2400
Nb_3Sn (0K) [2]	18.2	22.8 [2]	5350 [2]	520	173000	4010
MgB_2 (4 K)	39	36.3	4290	300 [3]	220000 [3]	3210
MgB_2 (20 K)	39	25.4	2780	250 [3]	100000 [3]	2090

Proceedings of EPAC 2002, Tsuyoshi Tajima

2. Goals and status of research

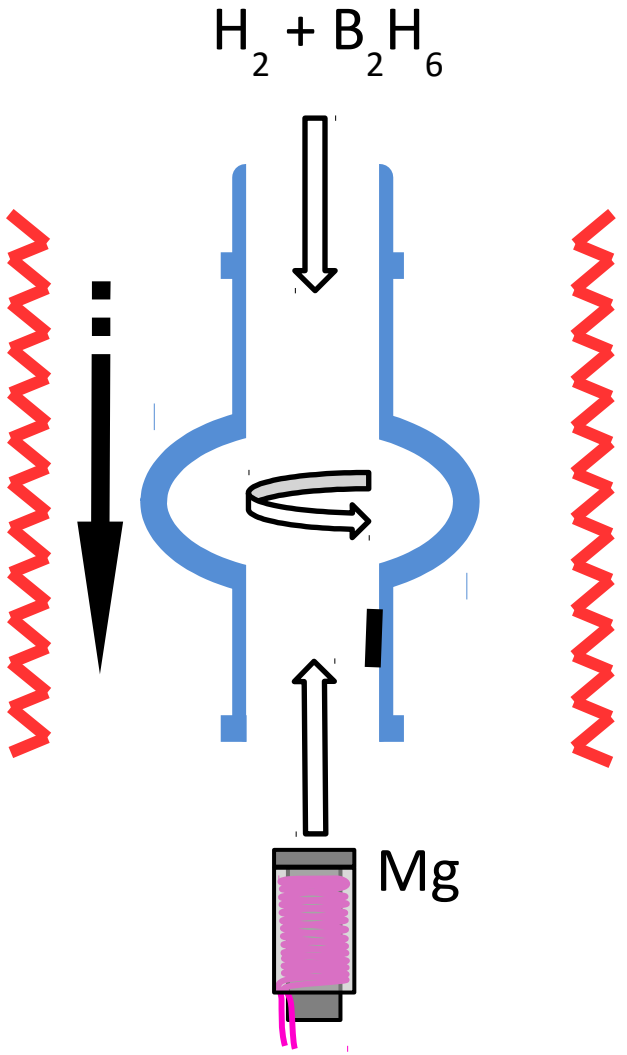


3. Film measurement data of 3 GHz cavity

◈ MgB_2 on a mock cavity by HPCVD 2

$$Mg + B_2H_6 \rightarrow MgB_2 + 3H_2$$

Temperature of cavity ~ 720 °C
Pressure : 40 torr



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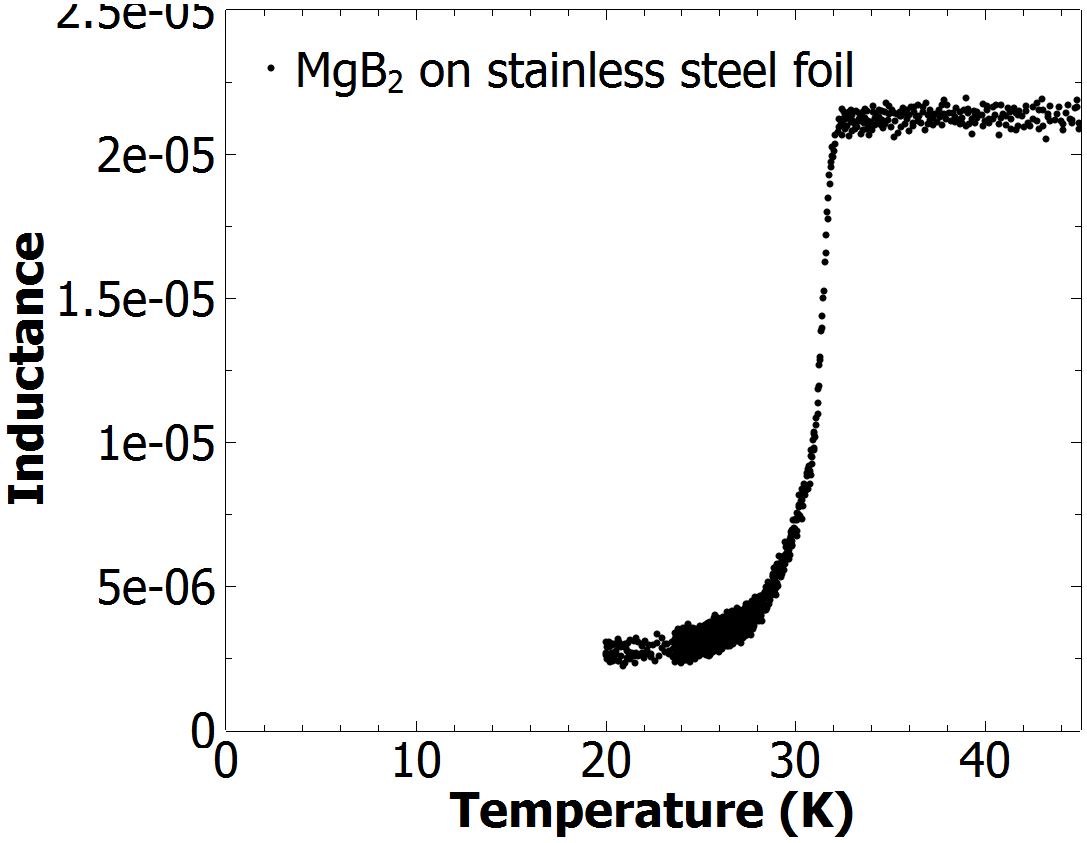

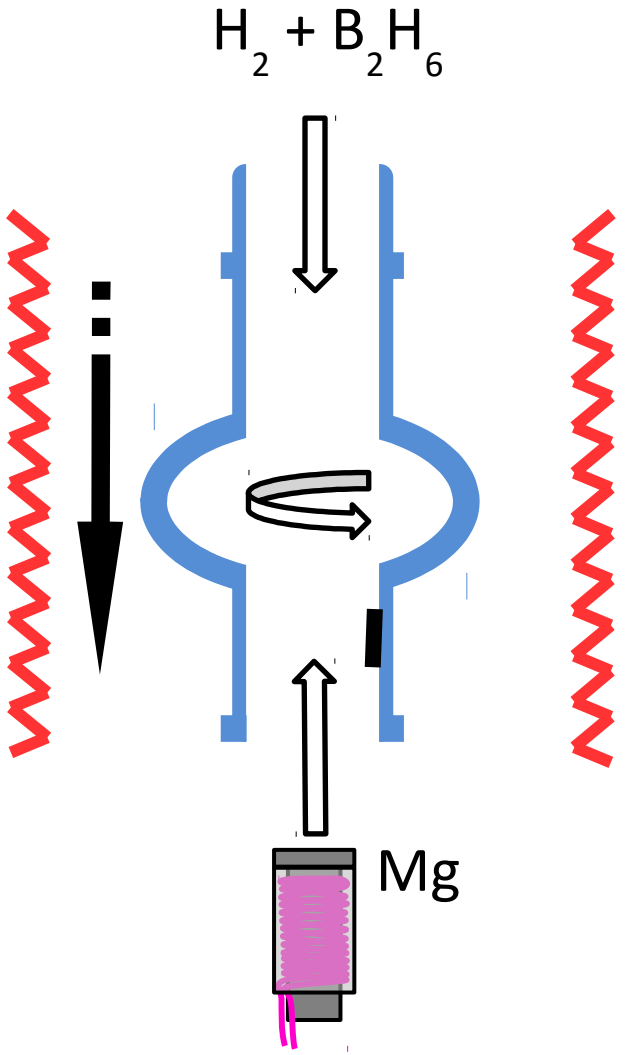

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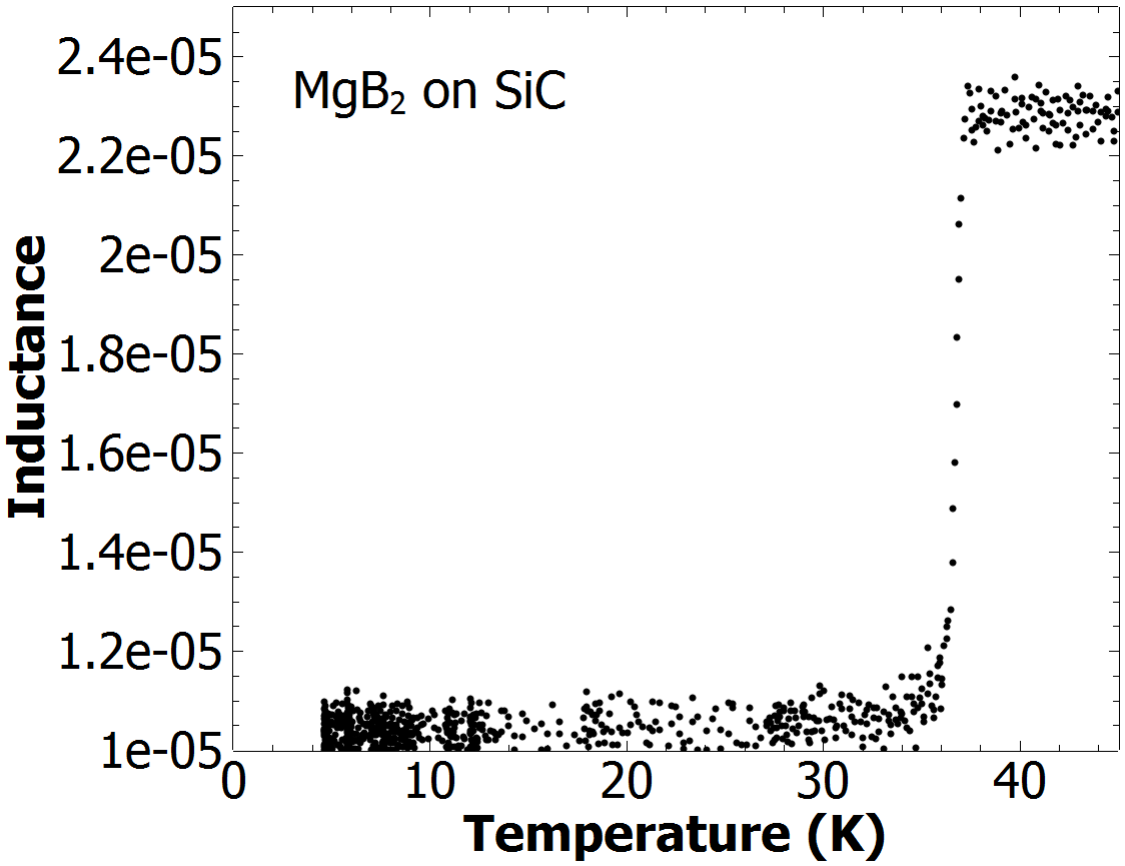

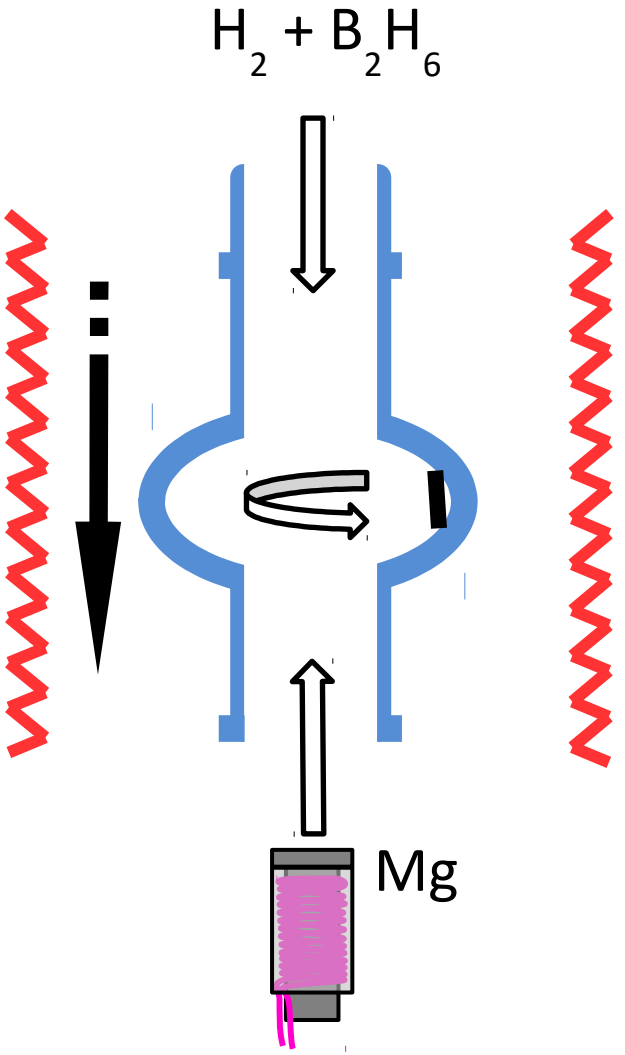

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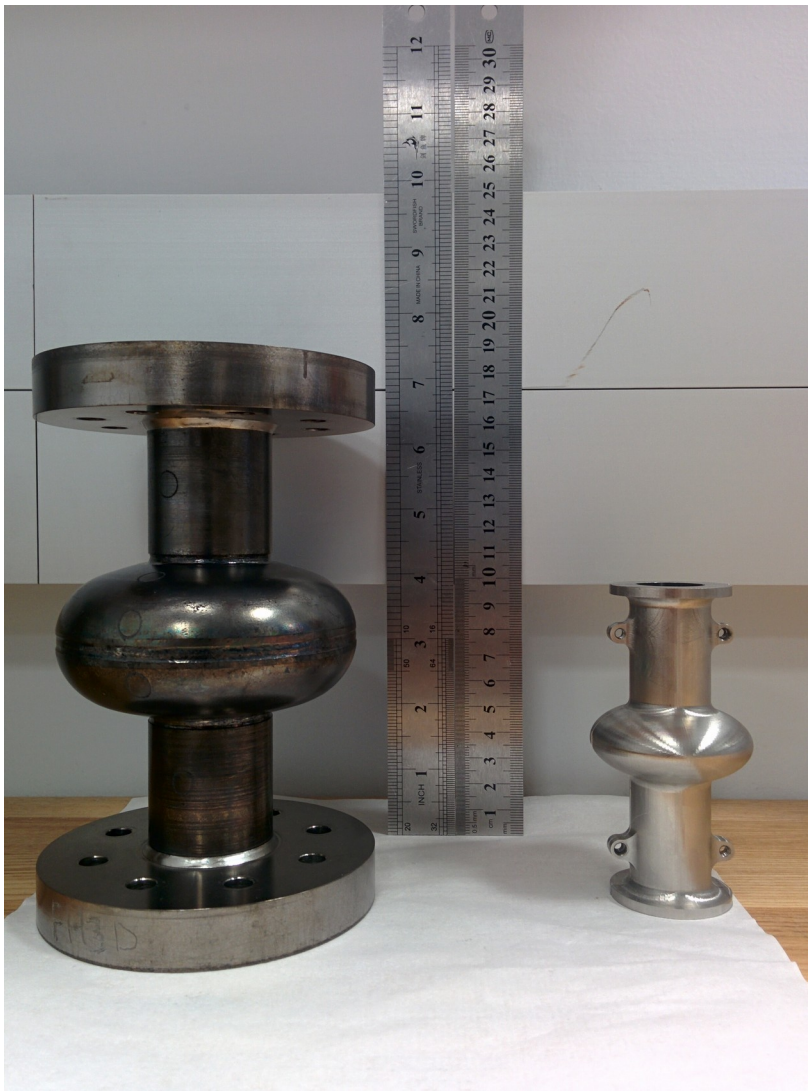
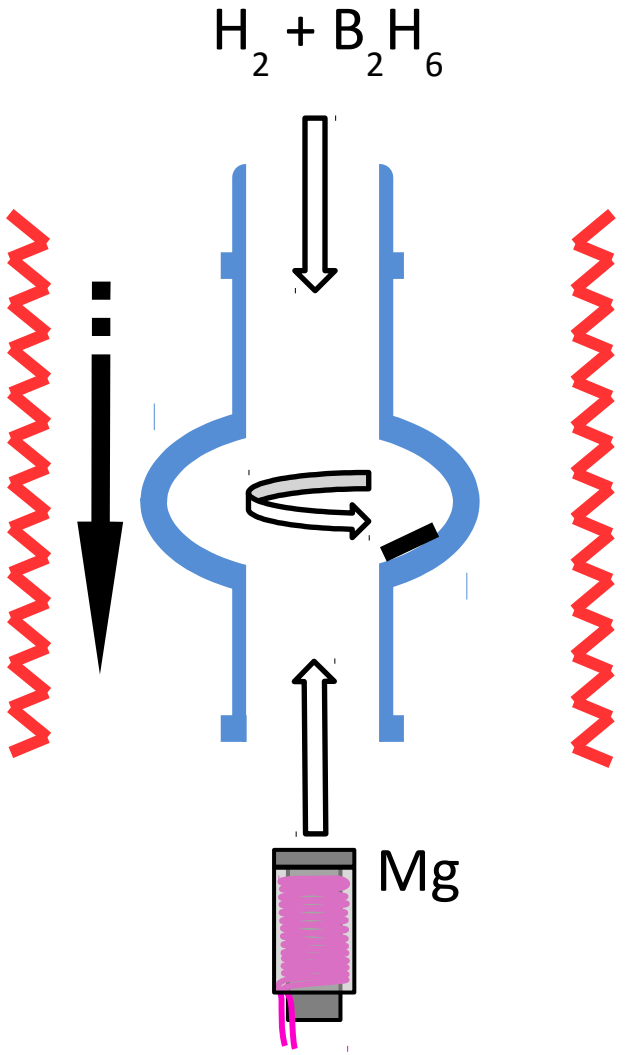
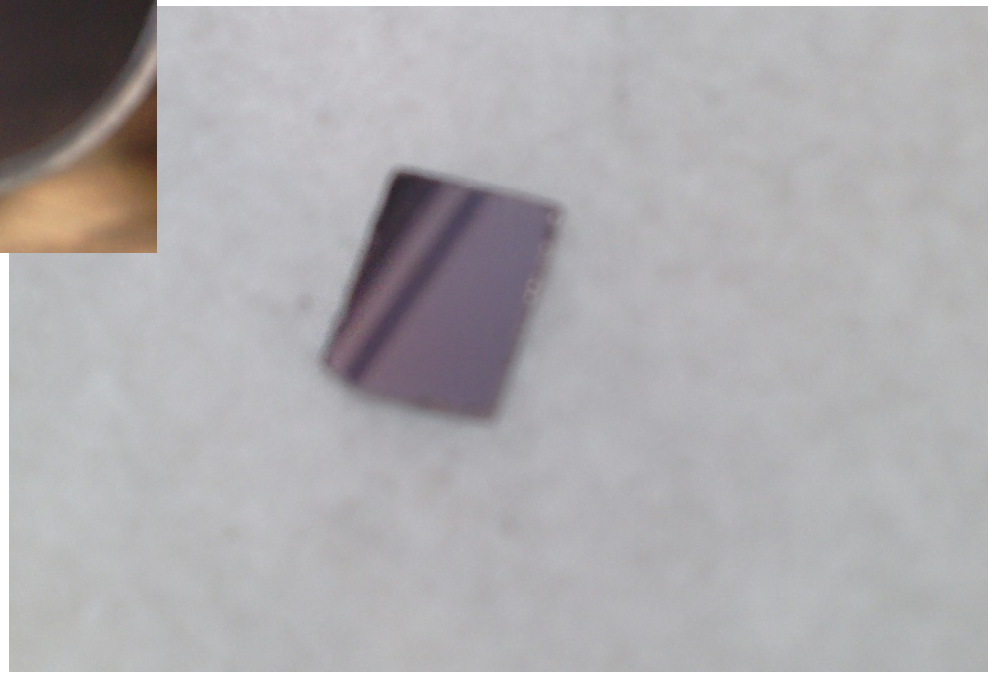




4. Film measurement data of 3 GHz cavity

◈ MgB_2 on a mock cavity by HPCVD



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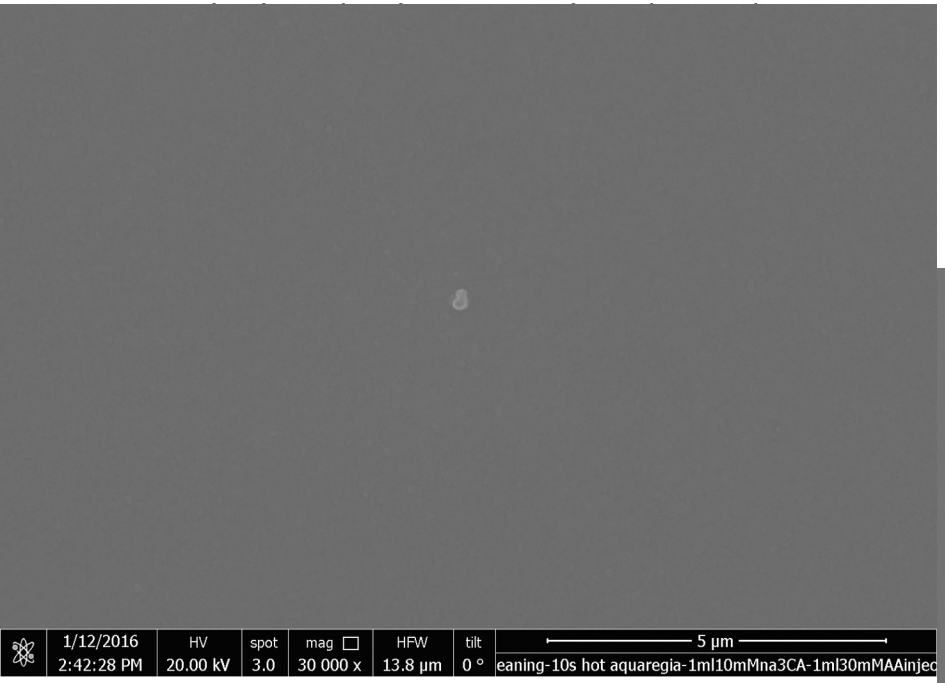
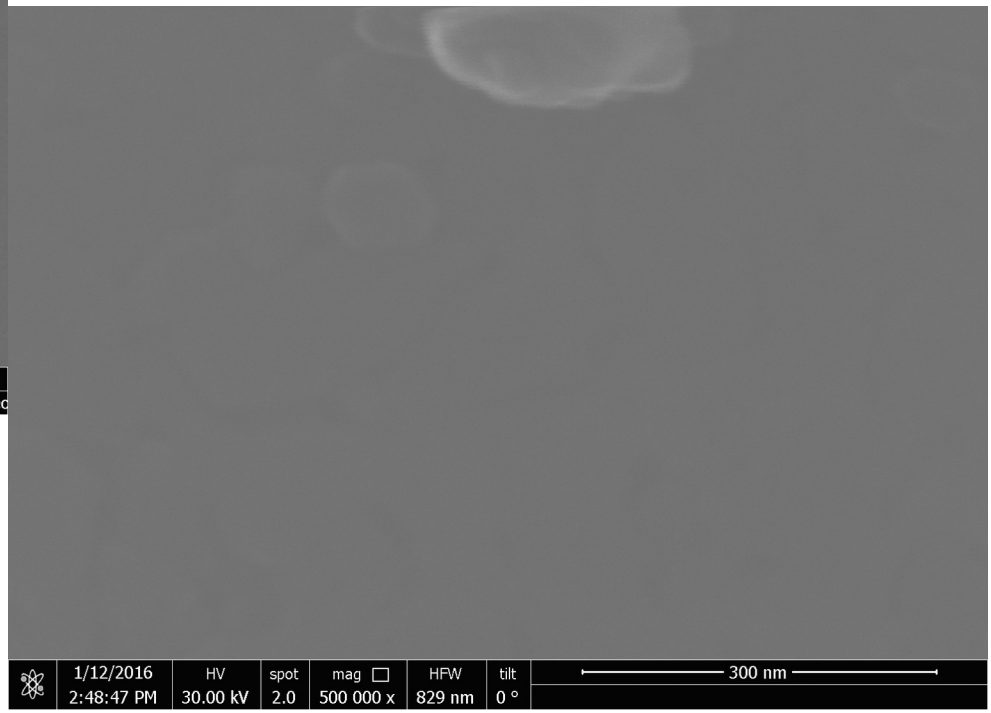
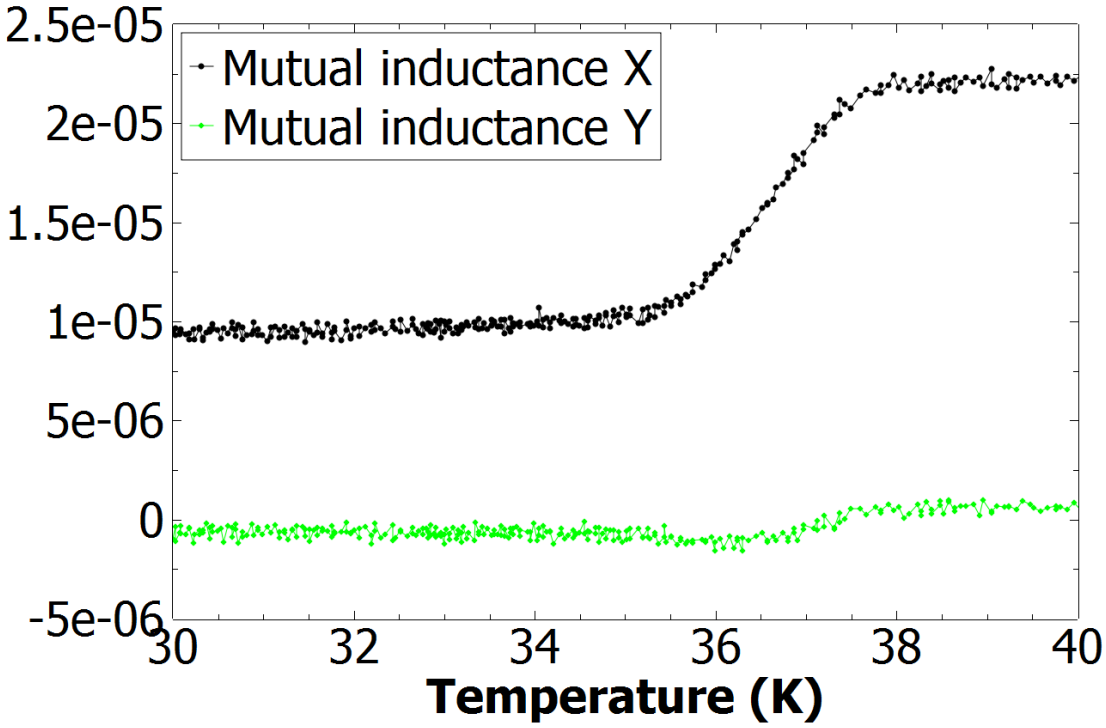


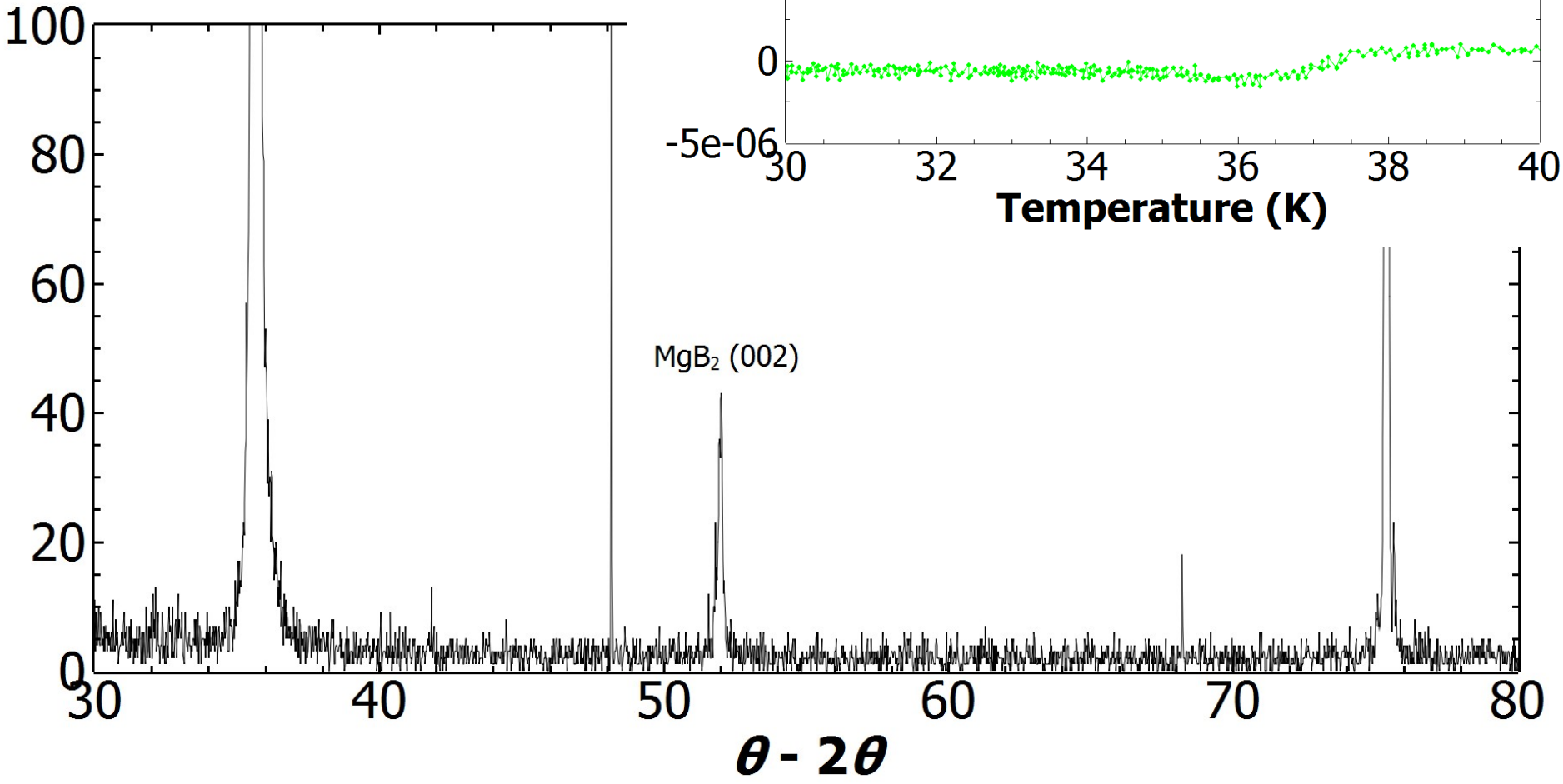


3. Film measurement data of 3

◈ Results

SiC substrate





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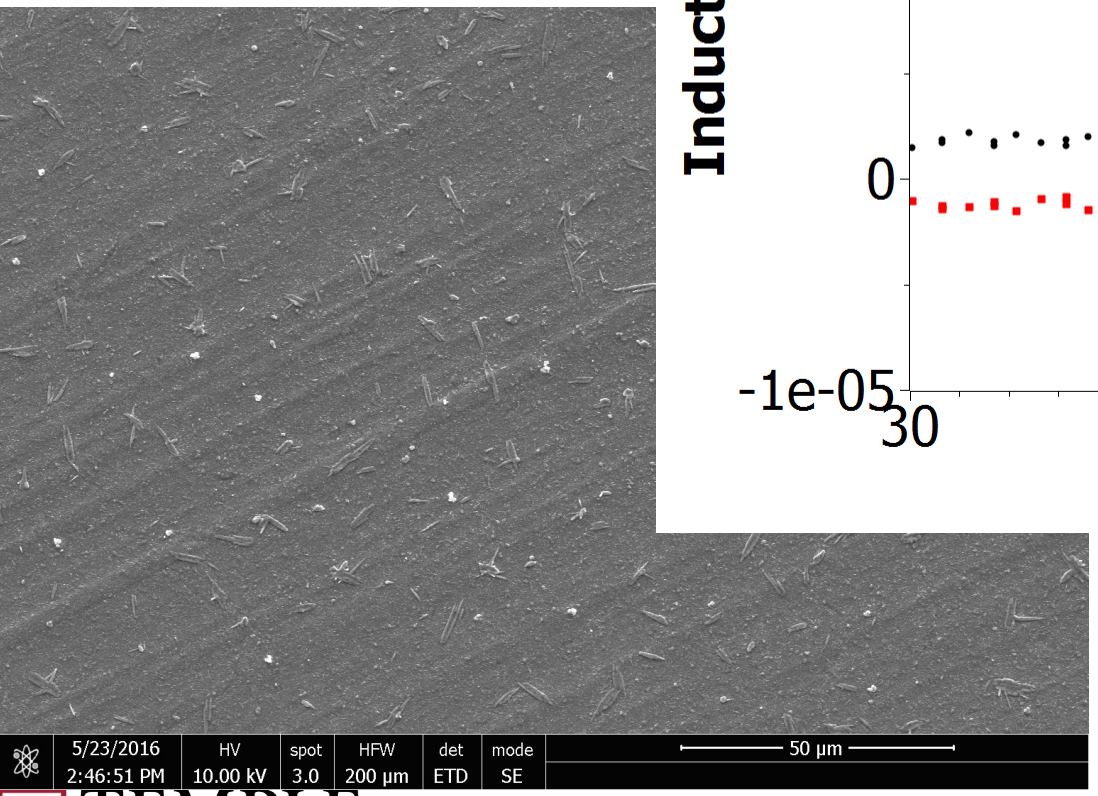
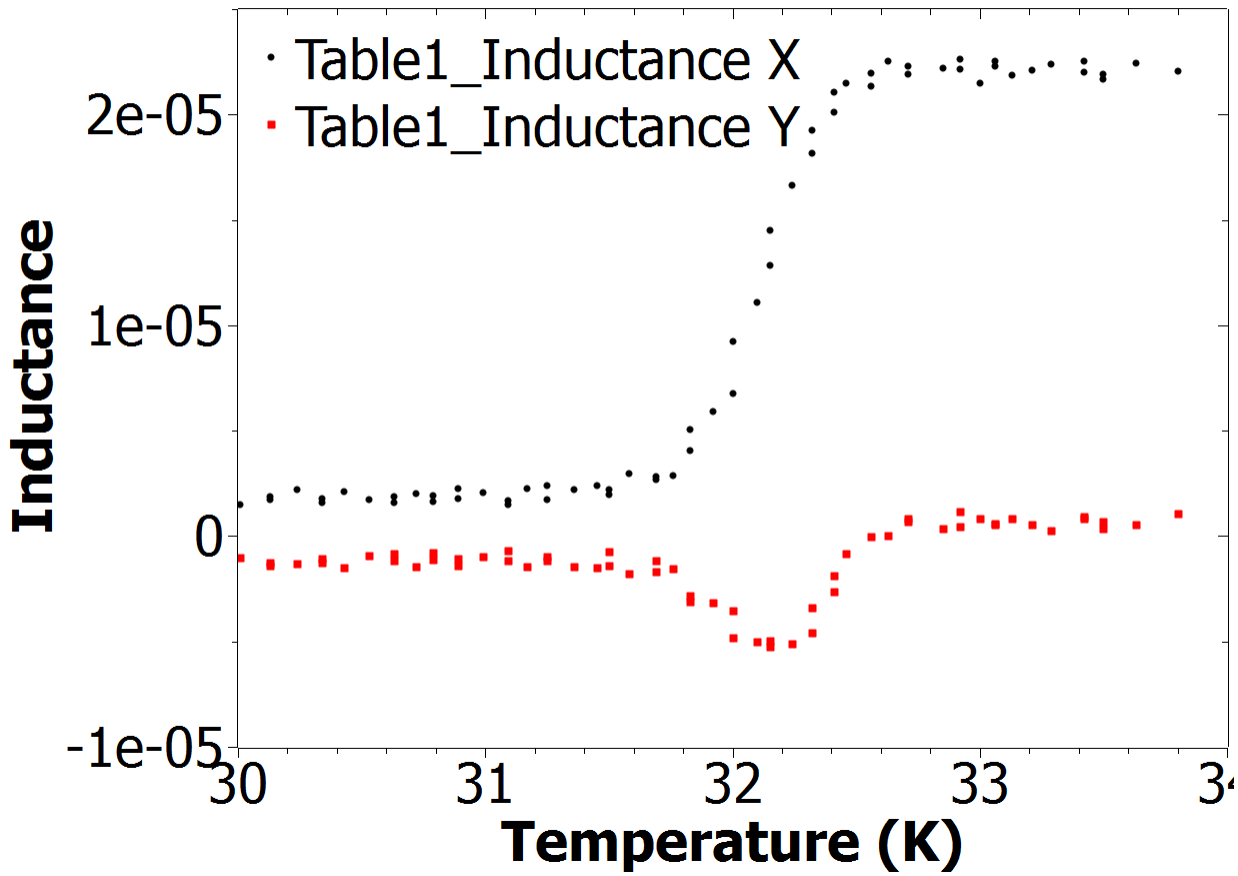
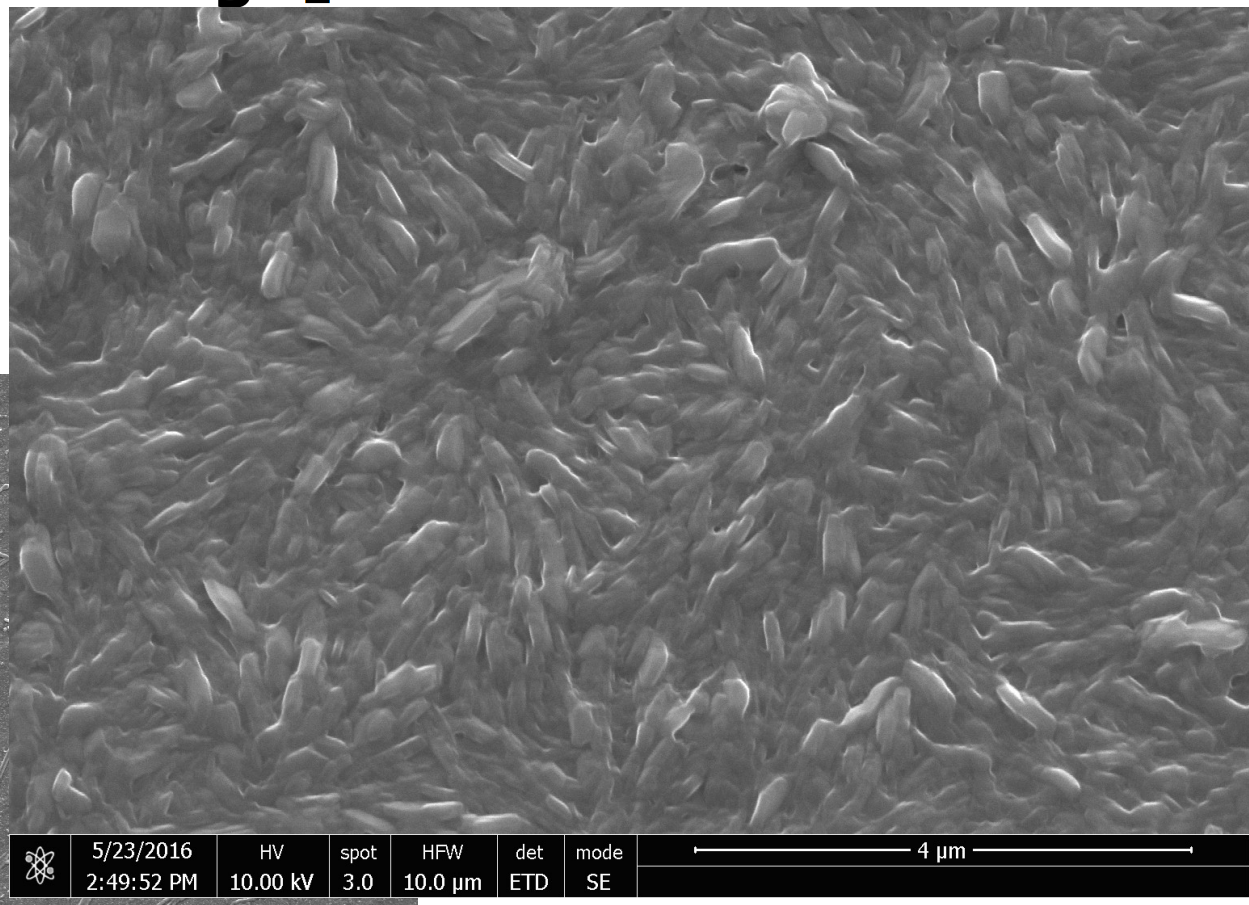


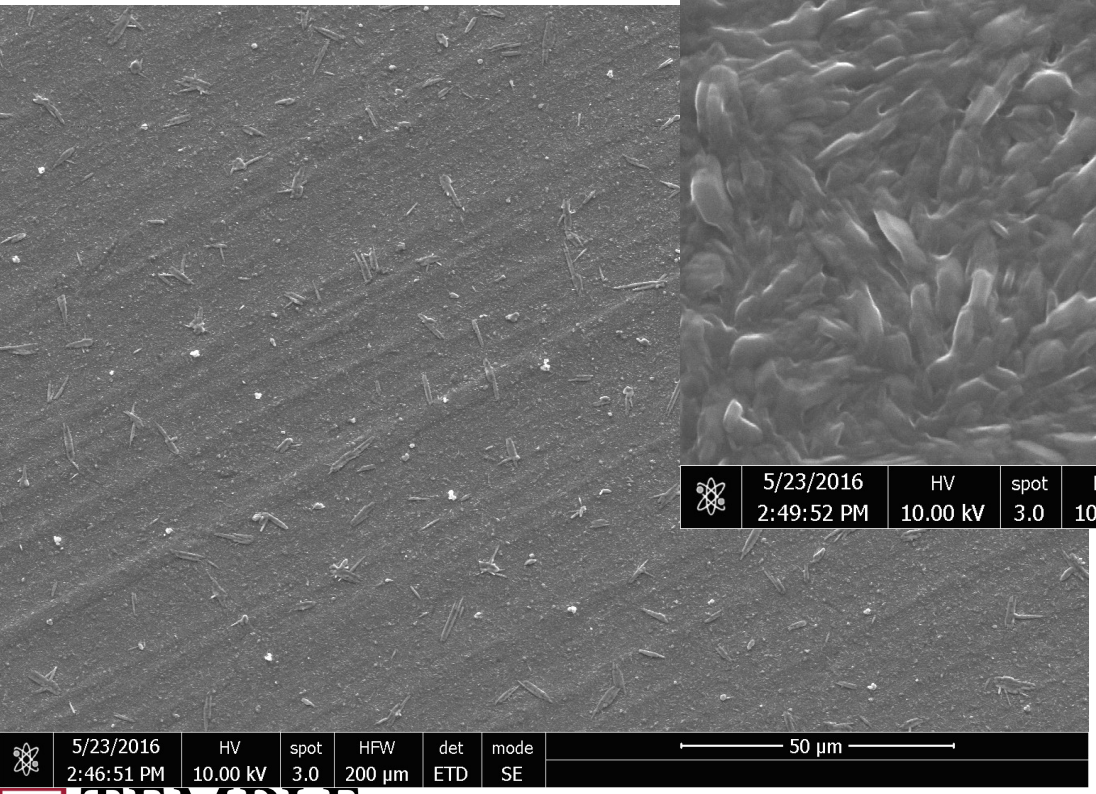


3. Film measurement data of 3 GHz cavity

◈ Results

MgB_2 on stainless steel foil





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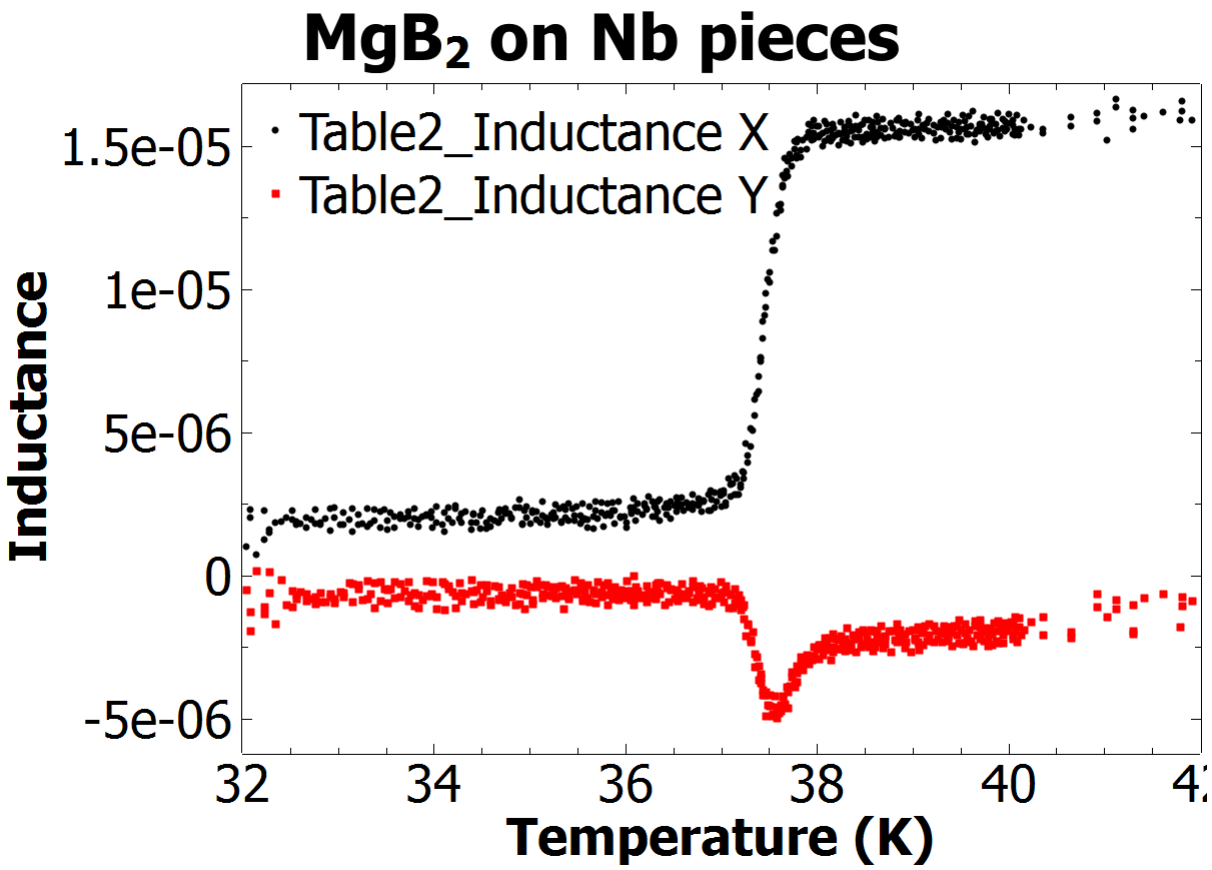

3. Film measurement data of 3 GHz cavity

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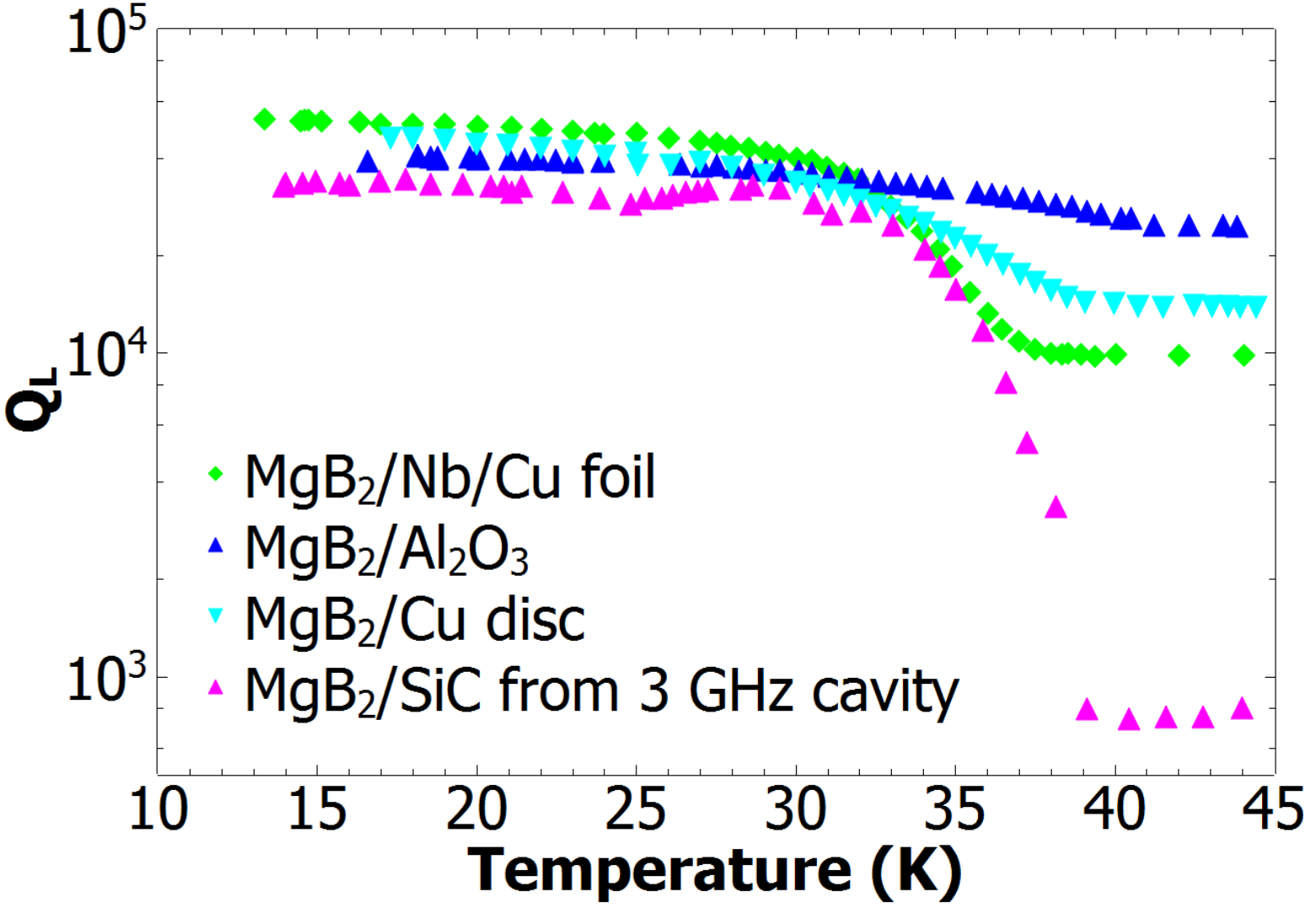

Summary

- MgB_2 is coated on a stainless steel 3 GHz mock cavity.
- Results of each films shows proper value for test.
- Nb cavity is being used for practical test.