2024. 01.25　第41回無機材料に関する最近の研究成果発表会
～材料研究に新たな風を～

高周波電磁環境を支えるギガヘルツ帯域電磁ノイズ吸収材料
～磁性材料と電磁波の相互作用による新たな機能創出～

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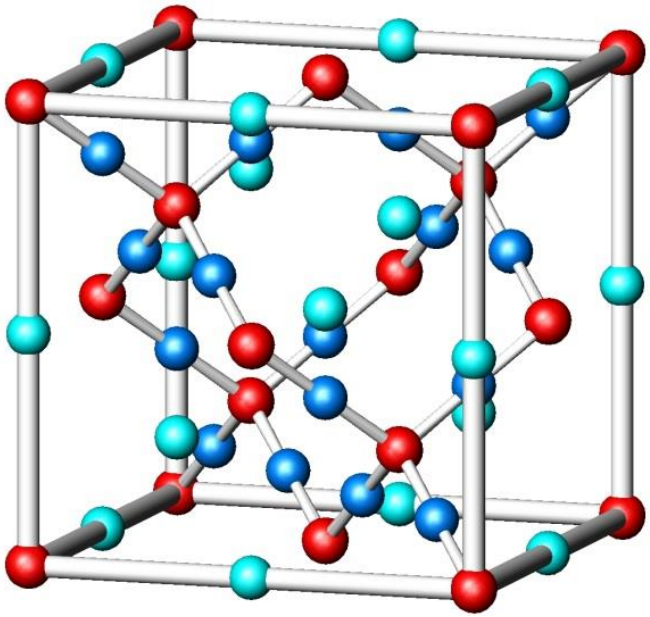
Objective

Electromagnetic wave absorbers for high frequency (GHz) noise

First study



$Ni_{0.5}Zn_{0.5}Fe_2O_4$
Spinel-structured ferrite

Procedures: from $Ni_{0.5}Zn_{0.5}Fe_2O_4$ bulk ceramic to sheet

Starting materials

α-Fe_2O_3 (99.9 %), NiO (99.97%), and ZnO (99.997 %) powders

Mixture

Mixed for 2hrs using mortar and pestle

First sintering

1000 °C for 4hrs in Air

Regrinding

Formation of pellets

10 MPa for 4min

Second sintering

1400 °C for 4hrs in Air

$Ni_{0.5}Zn_{0.5}Fe_2O_4$ bulk ceramic

Procedures: from $Ni_{0.5}Zn_{0.5}Fe_2O_4$ bulk ceramic to sheet

Slurry

$Ni_{0.5}Zn_{0.5}Fe_2O_4$ ceramic powders, $((–CH_2CH(OH)–)_{500}$ (polyvinyl alcohol), H_2O

Sheet formation

Doctor Blade method

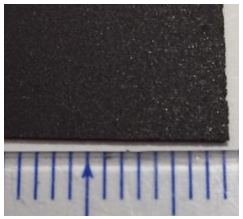
Dry

105 °C for 1h in Air

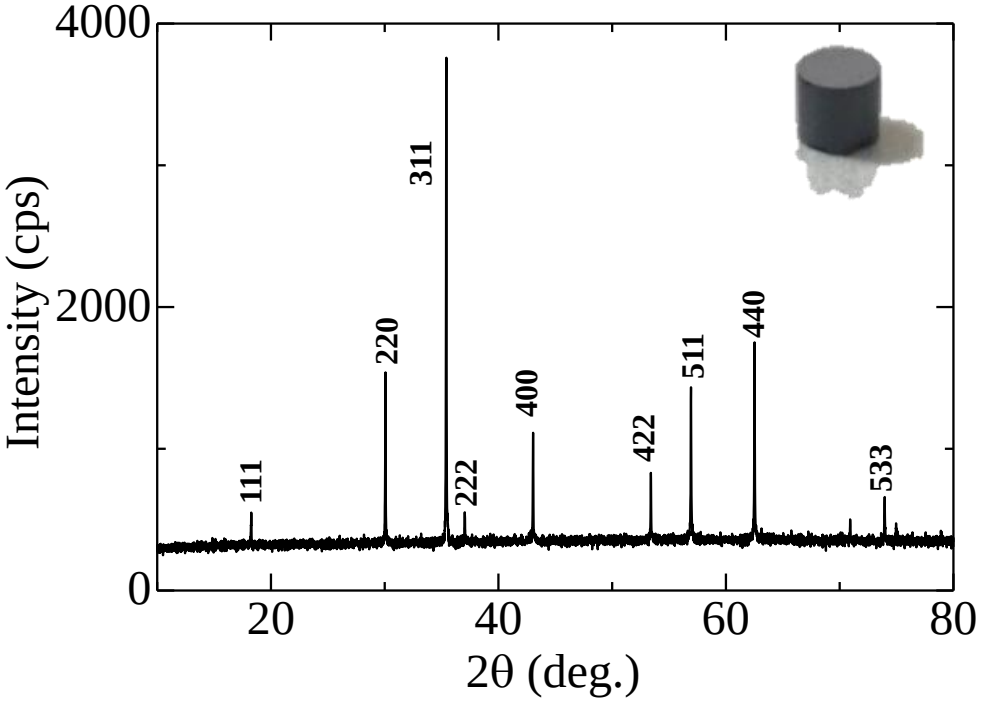
Stacking of two sheets

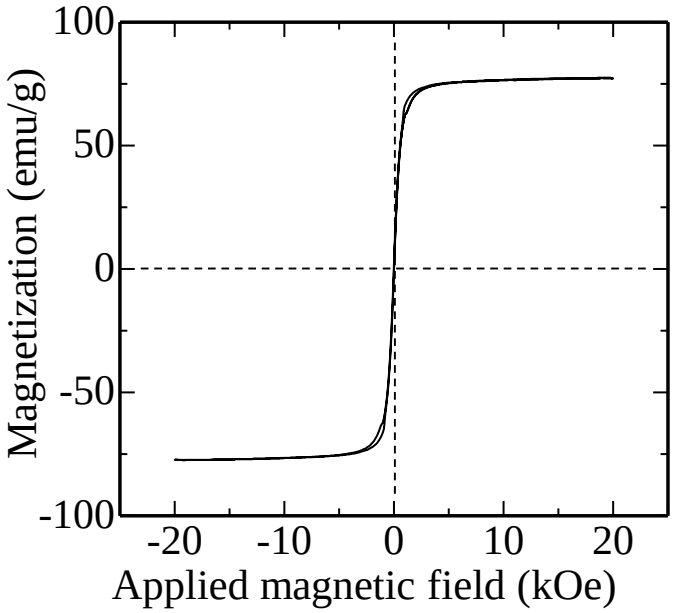
150 °C for 6min applying 25 kg/cm^2 using hot press

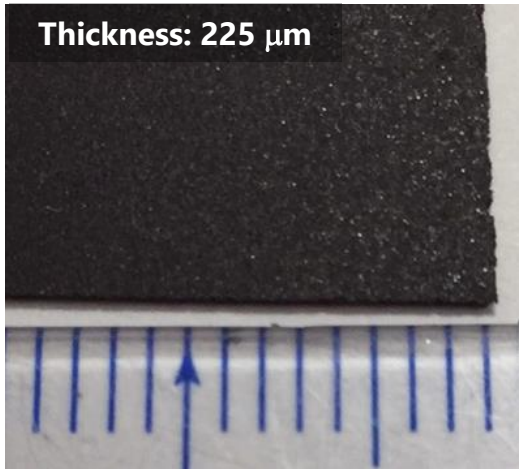
$Ni_{0.5}Zn_{0.5}Fe_2O_4$-containing sheet

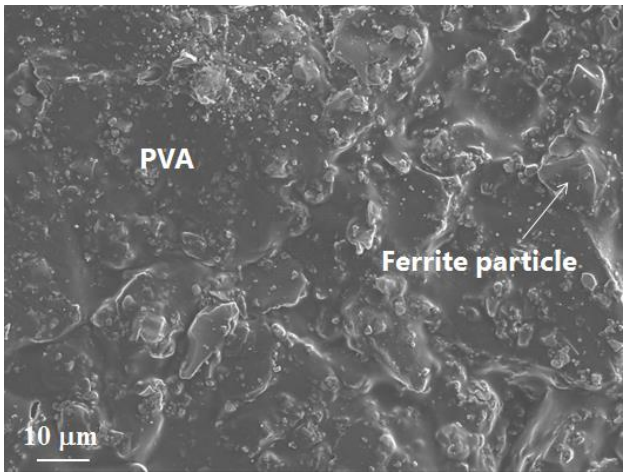


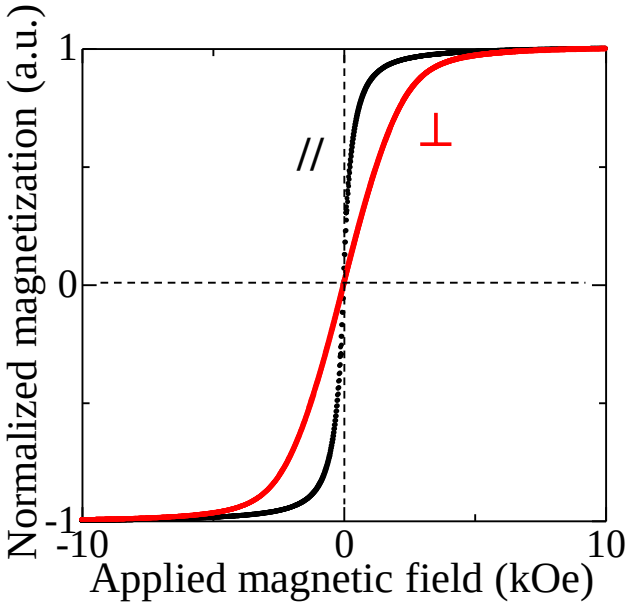
From $Ni_{0.5}Zn_{0.5}Fe_2O_4$ bulk ceramic to $Ni_{0.5}Zn_{0.5}Fe_2O_4$-containing sheet





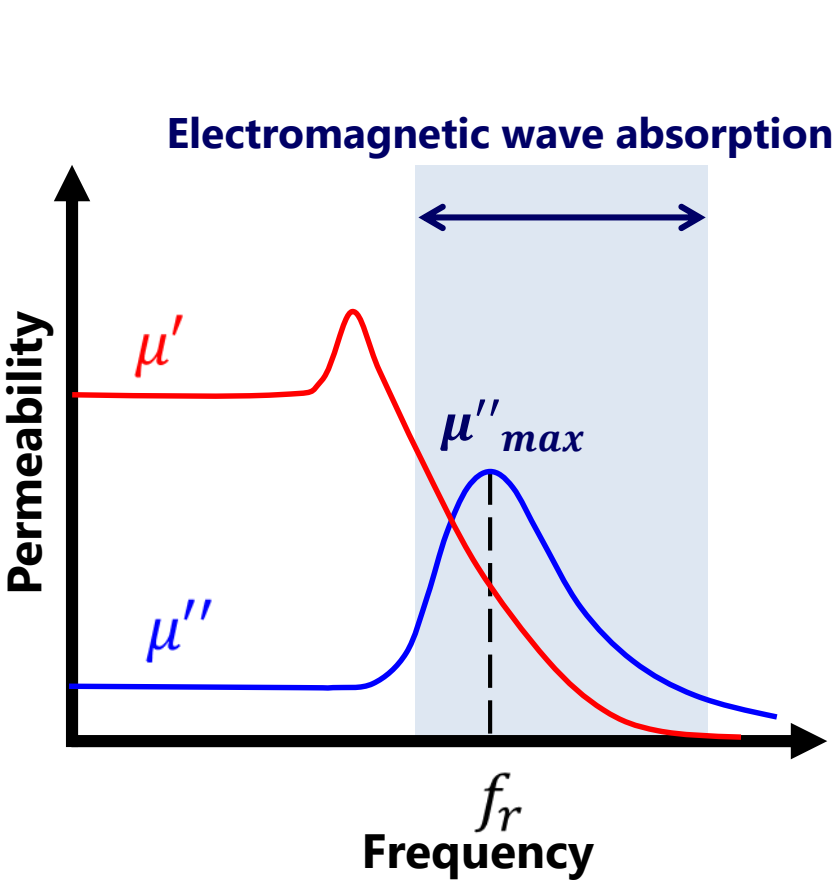


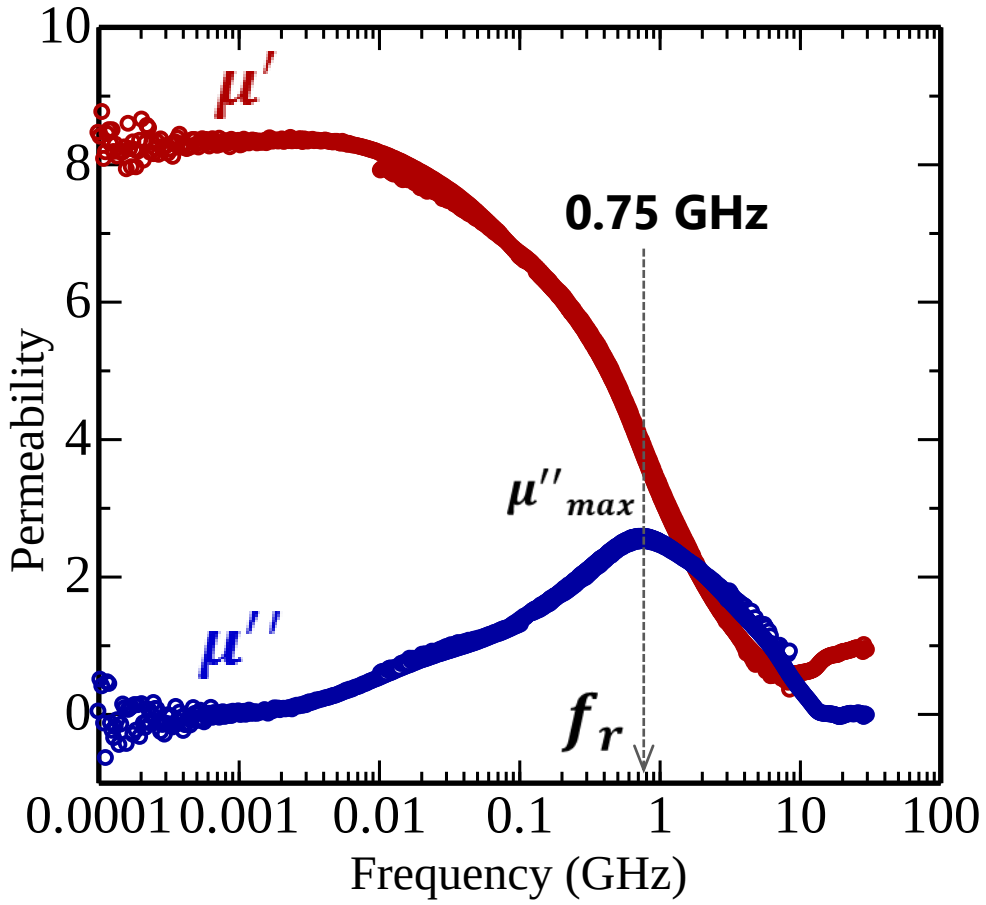




Y. Yasukawa et al., Scientific Reports, **11** 614 (2021).

Dynamic magnetic properties: complex permeability

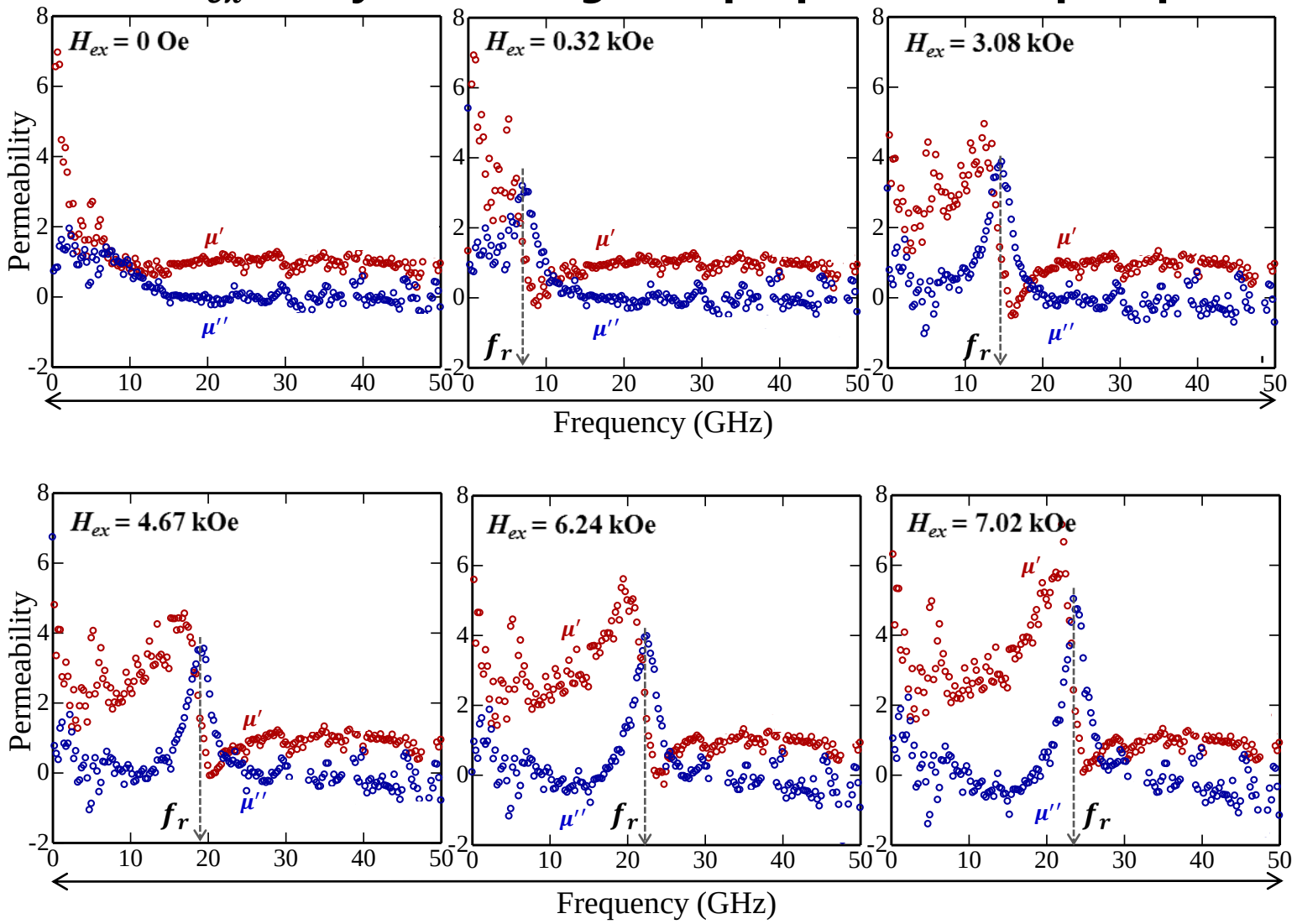




$f_r \sim 0.75$ GHz

Y. Yasukawa et al., Scientific Reports, **11** 614 (2021).

Influence of H_{ex} on dynamic magnetic properties: complex permeability

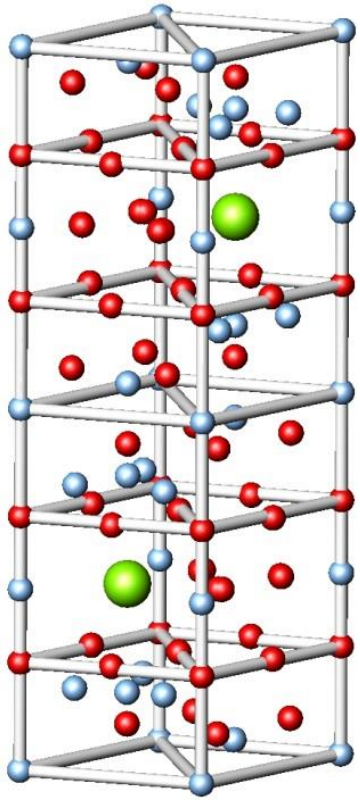


With increasing H_{ex}, f_r also increased

$f_r \sim 25$ GHz @$H_{ex} = 7.02$ kOe

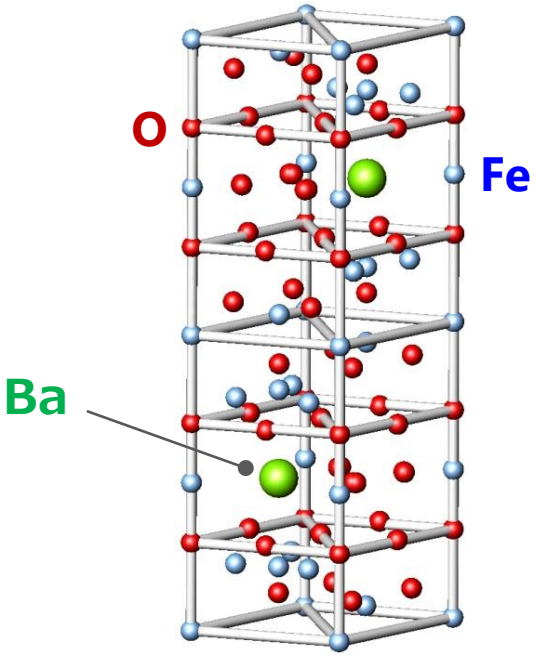
Y. Yasukawa et al., Scientific Reports, **11** 614 (2021).

Second study

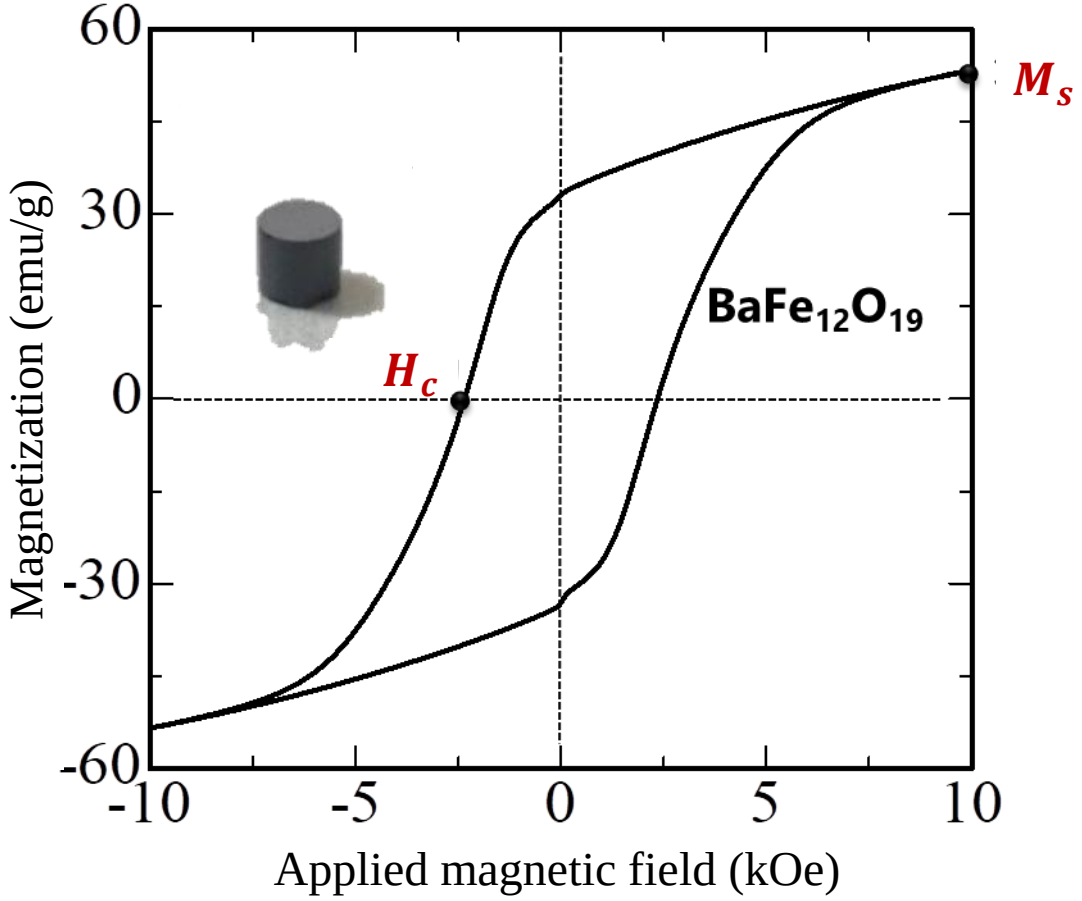


$BaFe_{12}O_{19}$
Magnetoplumbite-structured ferrite

Fundamental magnetic properties of bulk ceramic $BaFe_{12}O_{19}$



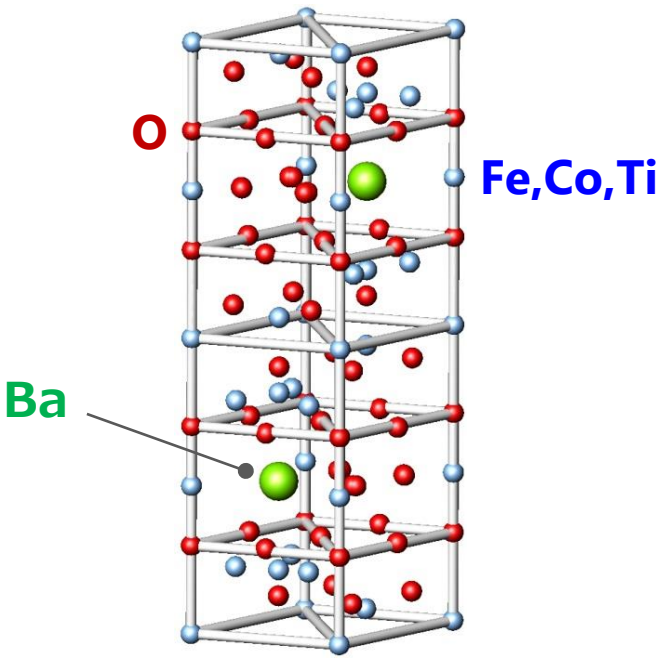
$BaFe_{12}O_{19}$



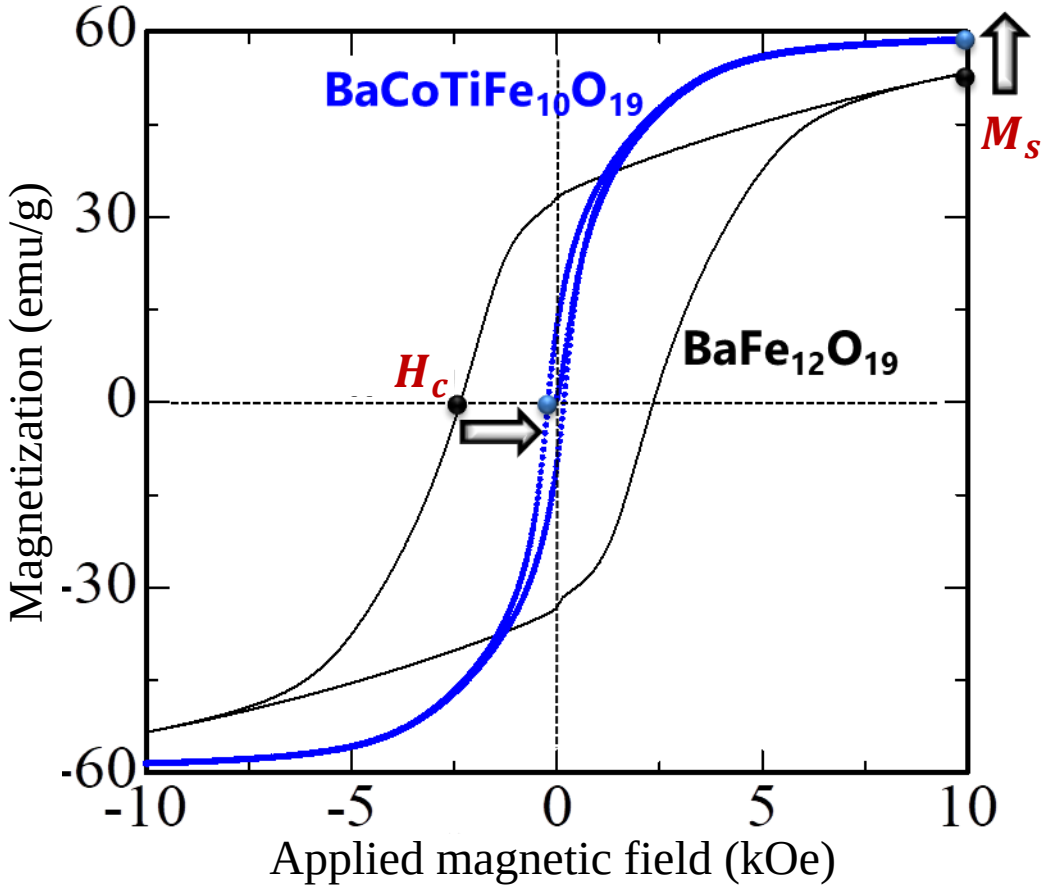
$$\mu = \frac{B}{H} \cong \frac{B_s}{H_c} = \frac{4\pi M_s}{H_c}$$

Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

Fundamental magnetic properties of bulk ceramic $BaCoTiFe_{10}O_{19}$

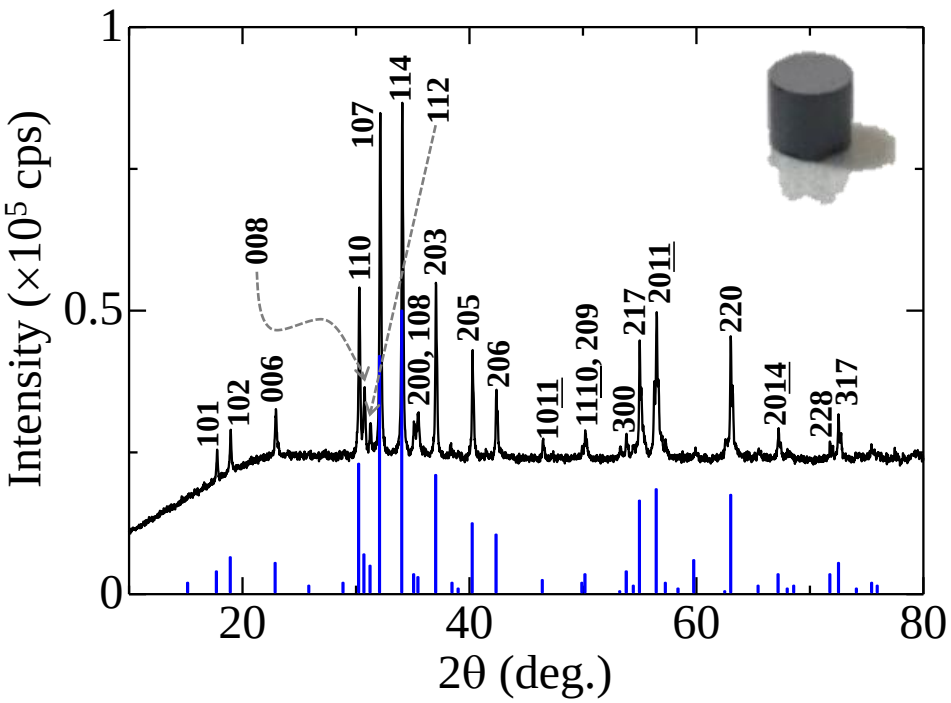


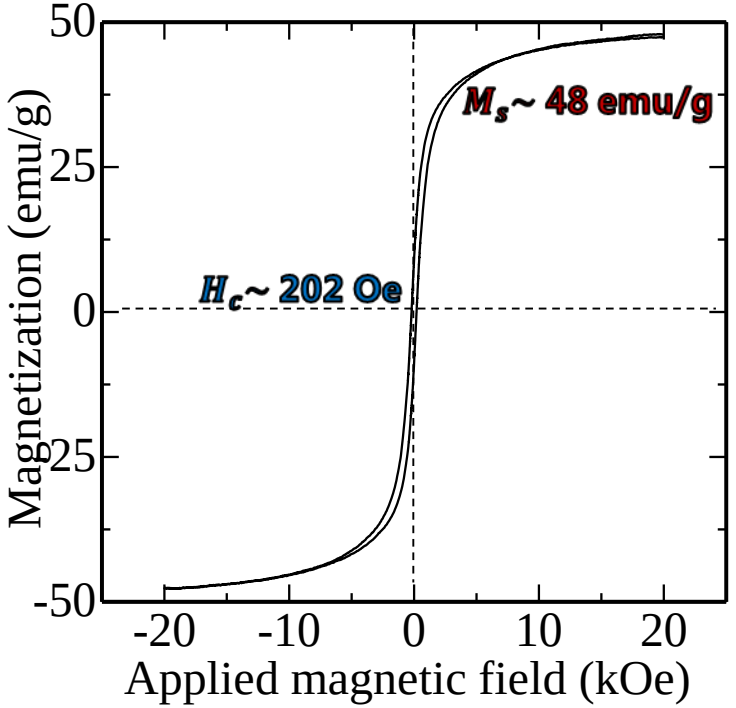
$BaCoTiFe_{10}O_{19}$

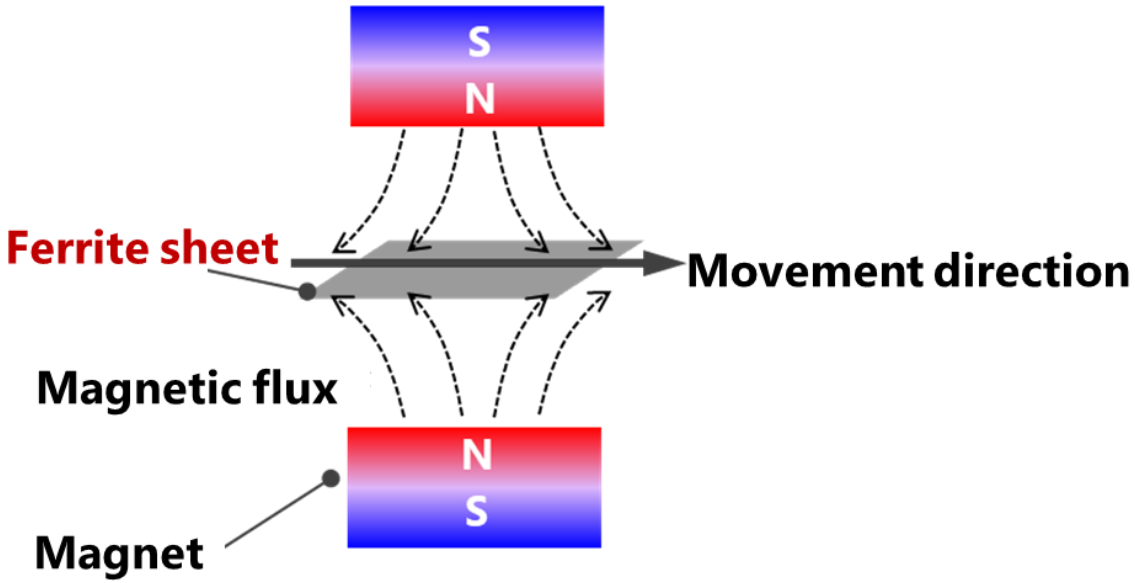


Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

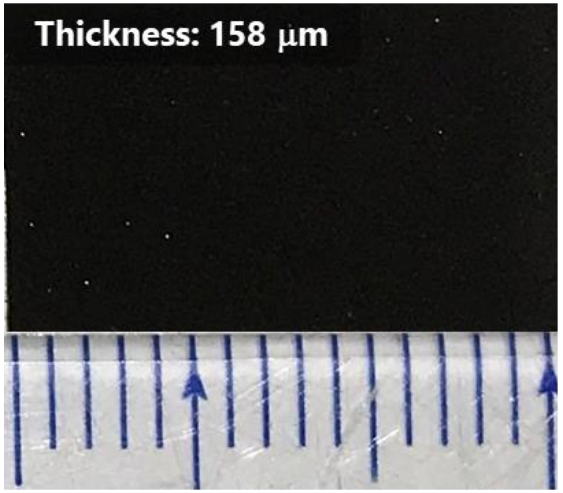
From $BaCoTiFe_{10}O_{19}$ bulk ceramic to $BaCoTiFe_{10}O_{19}$-containing sheet

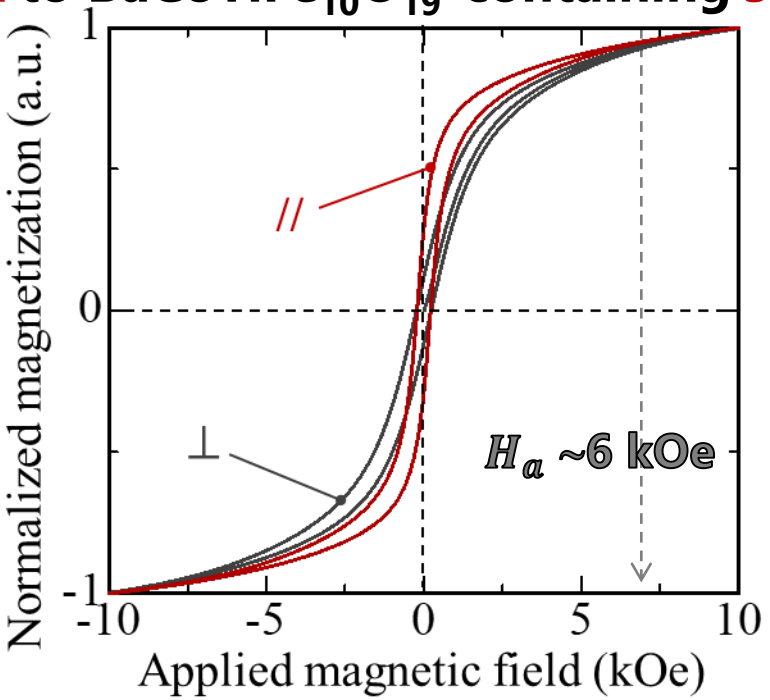


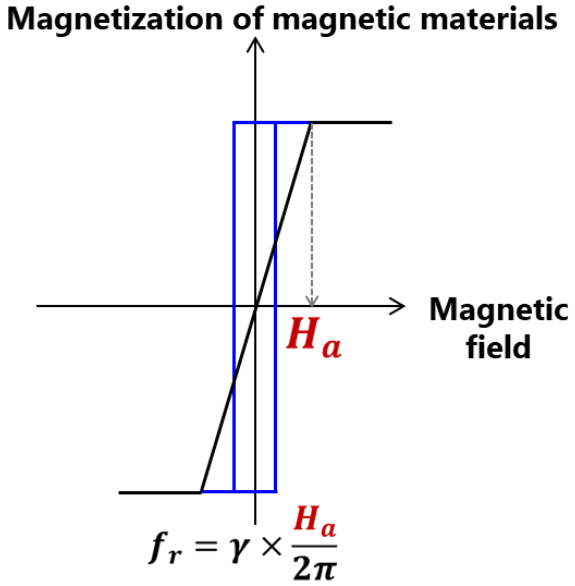




From $BaCoTiFe_{10}O_{19}$ ceramic bulk to $BaCoTiFe_{10}O_{19}$-containing sheet

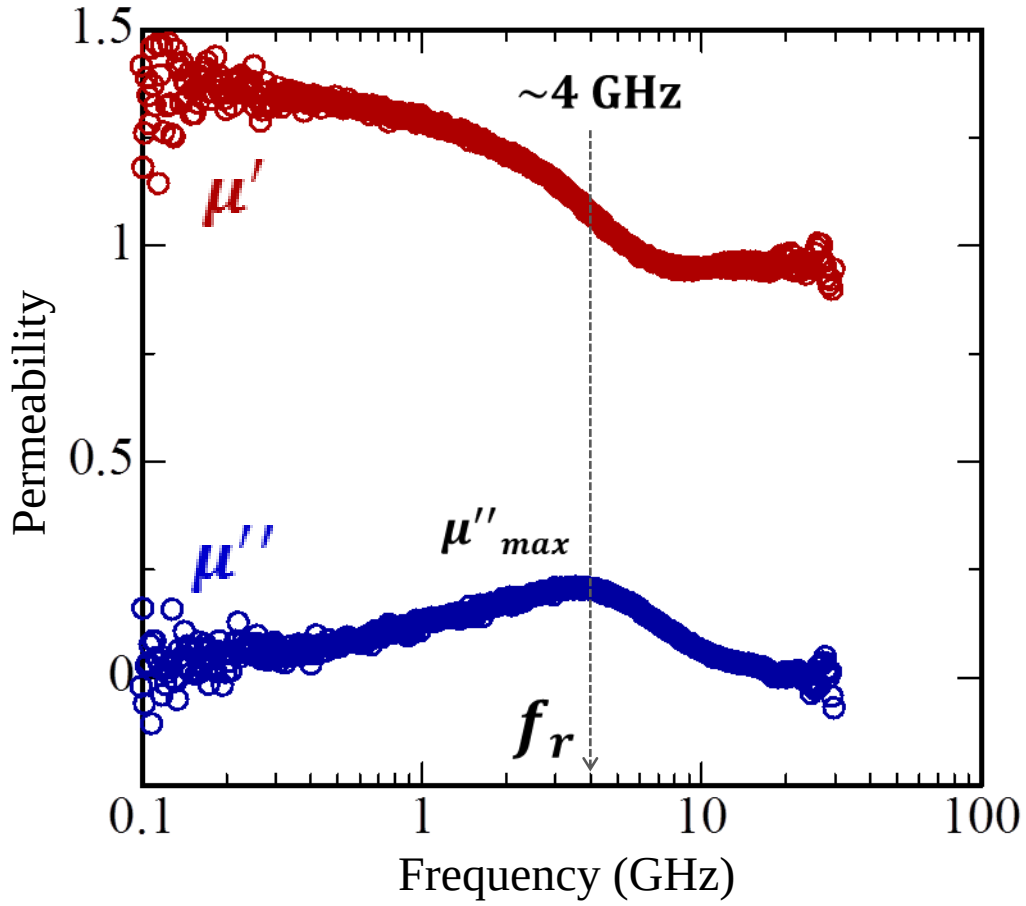






Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

Dynamic magnetic properties: complex permeability



f_r~ 4 GHz

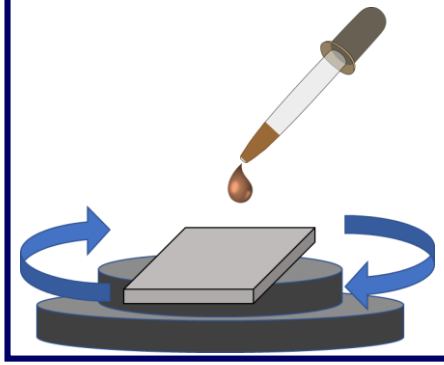
Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

Procedures: $BaCoTiFe_{10}O_{19}$ thin film

Starting material

Mixture of Ba, Co, and Ti-cation containing organic solution

Coating



Si substrate
250 rpm for 20 sec
3000 rpm for 30 sec

10 times
Repetition

First heating

100 °C for 10min in Air

Second heating

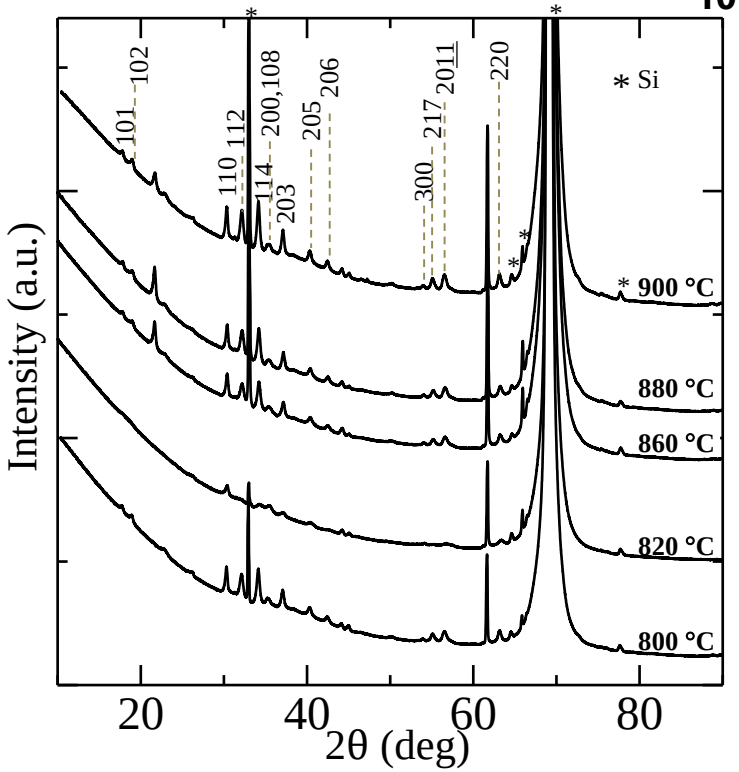
325 °C or 350 °C for 15min in Air

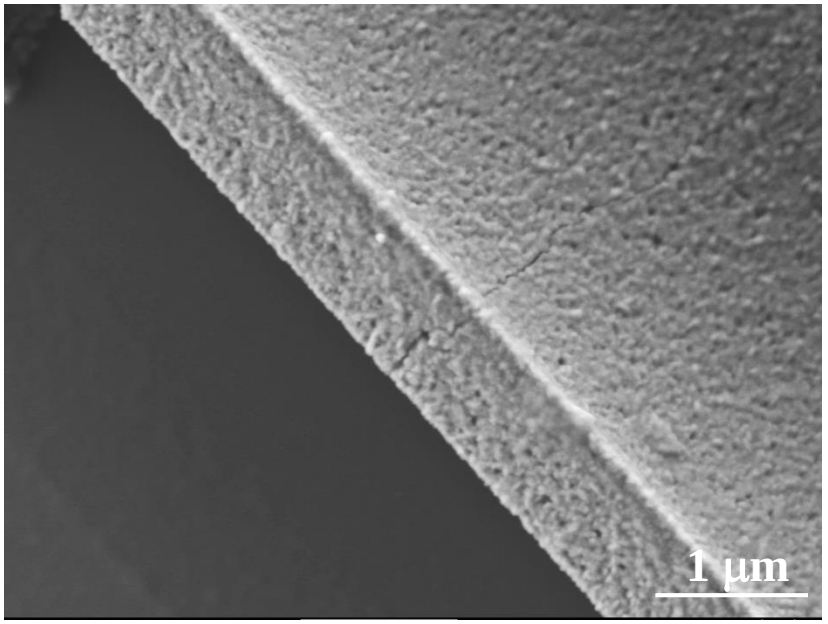
Sintering

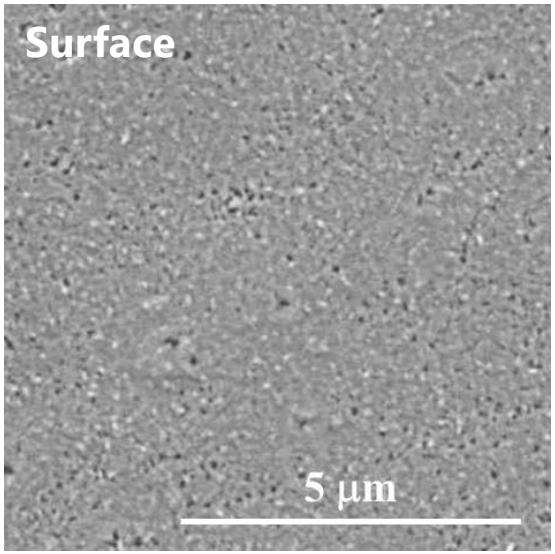
800 °C to 900 °C for 1hr / 840 °C for 2hrs in Air

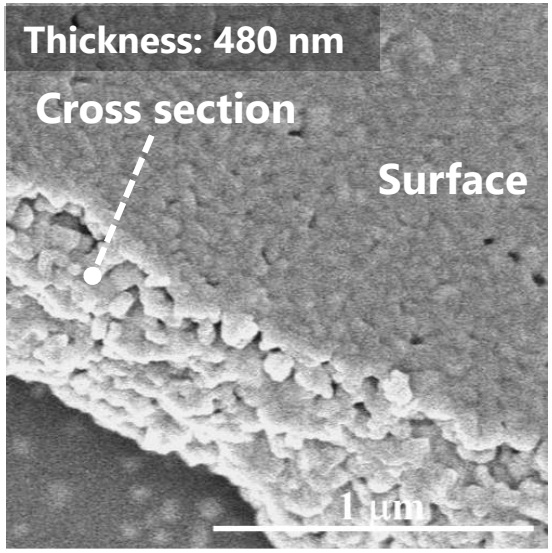
$BaCoTiFe_{10}O_{19}$ thin film

$BaCoTiFe_{10}O_{19}$ thin film



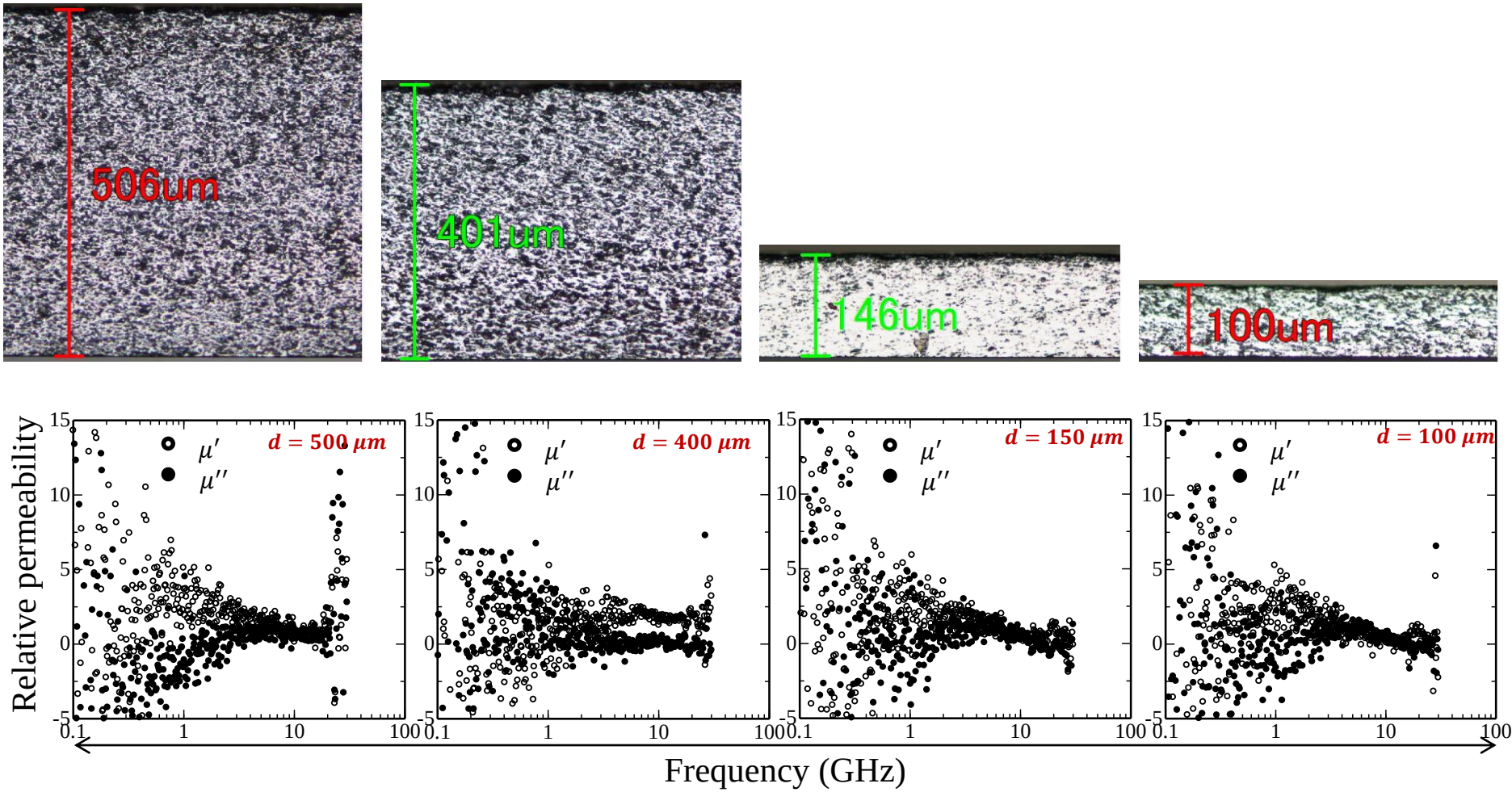






Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

Dynamic magnetic properties: complex permeability



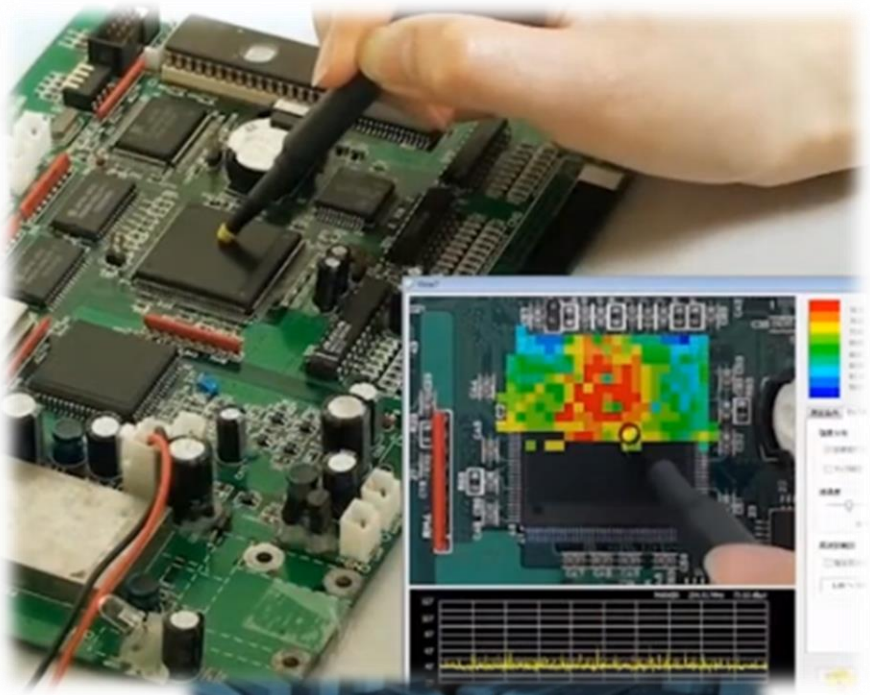
Unclear dynamic magnetic properties

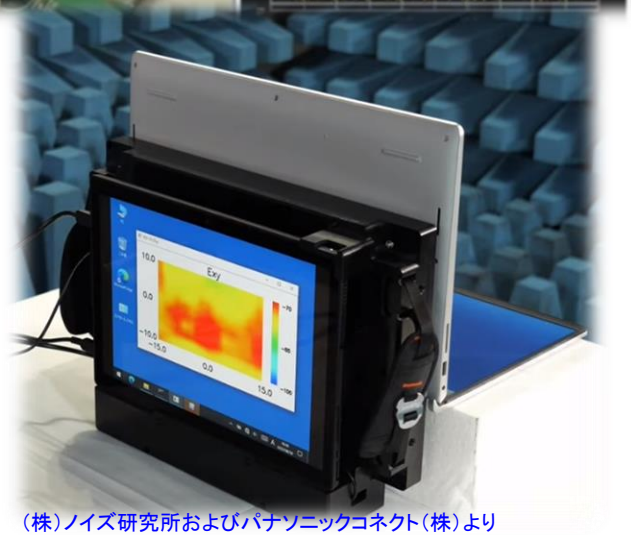
$f_r \sim$ 5 GHz @ 100μm???

Y. Yasukawa and C. Takahashi, Electrochemistry, **88** 515 (2020).

Conclusion

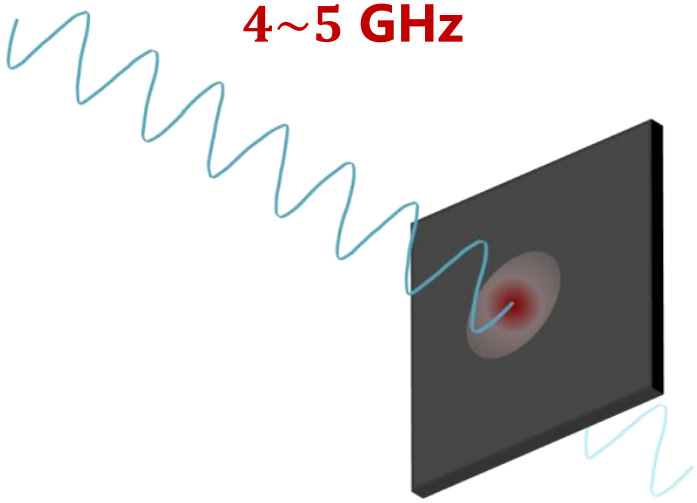
Electromagnetic wave irradiation





（株）ノイズ研究所およびパナソニックコネクト（株）より

Present study



$BaCoTiFe_{10}O_{19}$ sheets and thin films