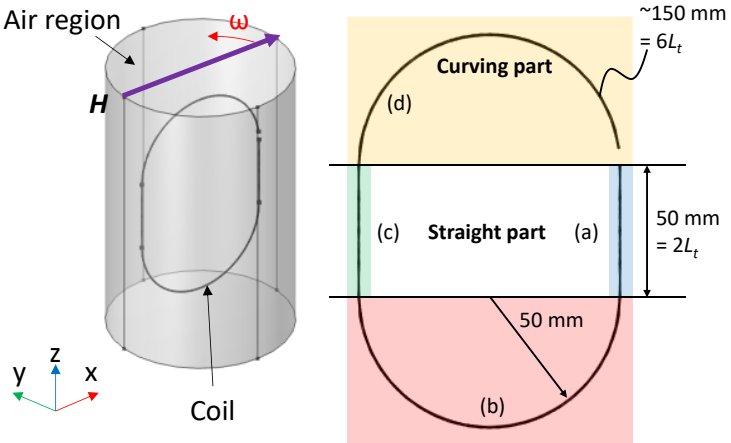
Modeling of MgB_2 windings under rotating magnetic fields

*Satsuki Okumura[1], Hiroyuki Ohsaki[1]

[1] *University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba, 277-8561, Japan*

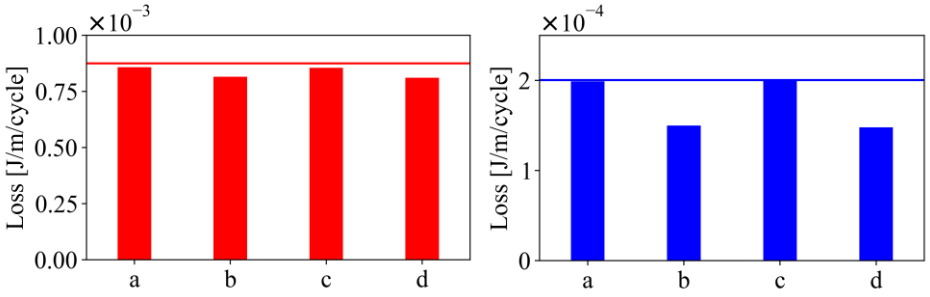
Abstract

In recent years, the performance improvement of high-temperature superconducting wires and cables has raised expectations for AC applications. In particular, rotating electric machines are attracting attention as a representative example of AC applications. There are two types of superconducting rotating machines: fully superconducting rotating machines and partial superconducting rotating machines. We are focusing on fully superconducting rotating machines, which use superconductors in the field windings and armature windings. While fully superconducting rotating machines have the advantage of high power density, AC losses occur in the armature windings and cause a problem. Evaluating AC losses is extremely important in the design of a fully superconducting rotating machine. We consider a racetrack shaped winding using a multi-filament MgB_2 wire with a circular cross section to estimate its AC losses through numerical analysis and experiments [1,2]. COMSOL Multiphysics is used for FEM analysis of the model shown in Figure 1, and a rotating magnetic field is applied to the coil. AC losses in the racetrack shaped winding were successfully calculated with the proposed method and model. Numerical analysis results are shown in Figure 2. It was found that the AC losses are smaller in the coil end part than in the straight part, because a longitudinal magnetic field is applied to the coil end.



(a) (b)

Figure 1 Numerical analysis model: a) Analysis region, b) Coil model



(a) (b)

Figure 2 AC losses: (a) Hysteresis loss, (b) Coupling loss

References

1) S. Okumura et al. IEEE Trans. Appl. Super. Vol 35, pp1-5, 2025

2) Y. Terao et al. IEEE Trans. Appl. Super. Vol 33, pp1-5, 2023

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