The influence of geometric characteristics on the equivalent magnetic susceptibility of HTS bulk

Authors * Mayin Si [1], Zigang Deng[2], and Jun Zheng [2]

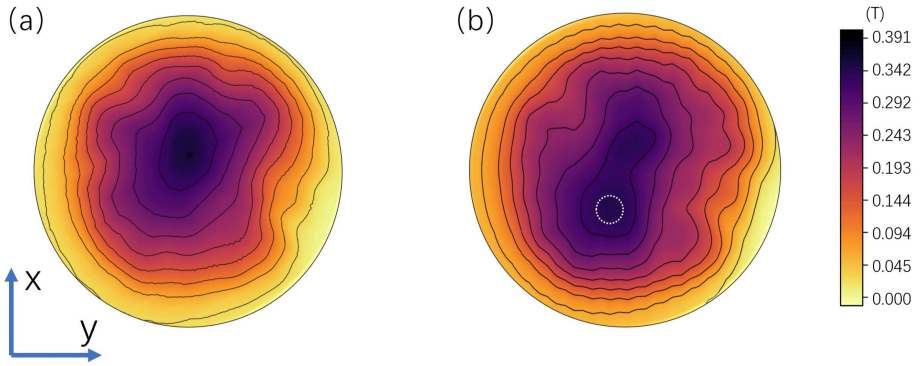
[1] *School of Information Science and Technology, Southwest Jiaotong University, Chengdu 610031, People's Republic of China*

[2] *State Key Laboratory of Rail Transit Vehicle system, Southwest Jiaotong University, Chengdu 610031, People's Republic of China*

Abstract

HTS maglev boasts advantages such as self-stabilization, energy efficiency, and environmental friendliness, and thus holds promising development prospects in fields like rail transit, superconducting bearings, and superconducting motors. Equivalent magnetic susceptibility is an important electromagnetic property of HTS bulks. It is not only affected by the magnetic field but also by the geometric characteristics of HTS bulks. This paper investigates the influence of the three-dimensional dimensions and semi-spherical shallow pit of HTS bulks on their equivalent magnetic susceptibility and improves the equivalent magnetic susceptibility model of HTS bulks. The research shows that the influence of the geometric structure of HTS bulks on the equivalent magnetic susceptibility is related to the direction of the magnetic field. This paper finds through experiments that there is no linear relationship between the equivalent magnetic susceptibility of HTS bulks and their geometric dimensions, and the dimension perpendicular to the magnetic field direction has a more significant impact on the equivalent magnetic susceptibility of the bulks. This paper measured the trapped field data of the bulk before and after processing the semi-spherical shallow pit and found that the shallow pit enhances the levitation force of the HTS bulk by improving its local magnetic susceptibility. The influence of shallow pits at different positions on the magnetic susceptibility of the bulk was studied. It was found that pits located far from the seed crystal result in a more significant increase in magnetic susceptibility. Additionally, the higher the horizontal magnetic field component at the position of the shallow pit, the smaller the magnetic susceptibility gain induced by the pit.

Finally, a model describing the influence of geometric structures on the equivalent magnetic susceptibility of HTS bulks was established, and the equivalent magnetic susceptibility model was verified through experiments. This research not only improves the study on the equivalent magnetic susceptibility of HTS bulks but also provides an effective method for further improving the carrying capacity of practical superconducting magnetic levitation and system design.



(a) (b)

Figure 1: Contour maps of the trapped field of the HTS bulk seeded surface: (a) before processing semi-spherical shallow pits; (b) after processing a semi-spherical shallow pit (white circle indicates the location of the shallow pit).

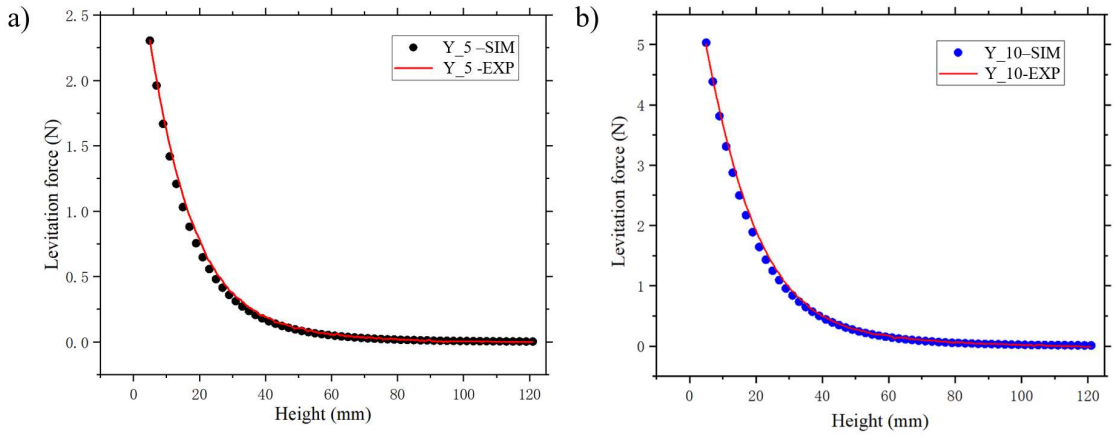


Figure 1: Calculated and experimental results of levitation forces of HTS bulk of different sizes at at different levitation heights: (a) 5*5*10mm bulk; (b) 5*10*10mm bulk.

References

[1] Y. Cheng et al. *Supercond. Sci. Technol.* Vol 34, 125017, 2021

[2] J. Zheng et al. *Supercond. Sci. Technol.* Vol 34, 035011, 2021

[3] H. Yong et al. *Superconductivity* Vol 10, 100097, 2024

[4] I. Peixoto et al. *IEEE Trans. Appl. Supercond.* Vol 31, 3600907, 2021

[5] Z. Yu et al. *J. Supercond. Novel Magn.* Vol 33, pp609, 2019

[6] K. Yokoyama et al. *J. Phys.: Conf. Ser.* Vol 871, 012050, 2017

[7] G. Jang et al. *J. Magn.* Vol 16, pp181-5

[8] Z. Yu et al. *Supercond. Sci. Technol*. Vol 33, 095004, 2020

[9] X. Liu et al. *J. Appl. Phys.* Vol 133, 143901, 2023

Keywaords: HTS bulk, magnetic susceptibility, geometric characteristics, shallow pit, magnetic force