Magnetic Properties Investigation of Impregnated Adhesive Laminated Fe-Based Amorphous by Vector Magnetic Measurement

Naoya Soda[a], Shunsuke Kato[a]

[a] *Ibaraki University, Graduate School of Science and Engineering, Hitachi, Ibaraki, Japan.*

Fe-based amorphous materials are very thin, have high magnetic permeability, and low iron loss. However, they have highly stress sensitivity, resulting in deterioration of their magnetic properties during an impregnated adhesive lamination process. Therefore, we fabricated an impregnated adhesive laminated amorphous sample and investigated its magnetic properties using a vector magnetic measurement apparatus. As a result, although magnetic properties of the laminated amorphous sample deteriorate after impregnated adhesive lamination process, iron loss of the sample is lower than a 0.2 mm thick single sheet of non-oriented silicon steel.

Keywords: amorphous; impregnated adhesive lamination; iron loss; vector magnetic properties.

1. Introduction

Although multi-polarization and high-speed rotation are effective in increasing the output of small motors, iron loss increases with the increase in excitation frequency. Therefore, we have been researching the development of small motors with high efficiency and high-power density using Fe-based amorphous materials. Amorphous materials have low iron loss due to their very thin plate thickness of 25 µm, which helps to suppress eddy current losses. However, because amorphous materials are not only thin but also very hard, making them difficult to blanking and interlocked lamination. In general, impregnated adhesive lamination and wire electrical discharge machining (WEDM) are used to produce motor iron cores with amorphous materials for prototype applications. However, amorphous materials have highly stress-sensitivity, resulting in deterioration of their magnetic properties during the impregnated adhesive lamination process. Therefore, we fabricated an impregnated adhesive laminated amorphous sample and investigated its magnetic properties using vector magnetic measurement techniques.

2. Results and discussion

Table 1 shows the measured samples. The amorphous is 2605HB1M made by PROTERIAL, Ltd. Twenty sheets of amorphous materials are laminated by impregnation adhesion and cut by WEDM into square samples for vector magnetometry measurement. Dimensions of measurement samples are 80 × 80 mm [1]. As a comparison, a single sheet of non-oriented silicon steel 20HX1200 made by Nippon Steel Corporation is measured. Fig. 1 shows vector magnetic properties (magnetic flux density vector loci, magnetic field strength vector loci, and *x*- and *y*-components of *B-H* loops) of silicon steel and laminated amorphous in B_{max}=1 T, α=0, θ_B=45°, f=50 Hz.

Table 1 : Specifications of measurement samples

	Amorphous (2605HB1M)	Silicon steel (20HX1200)
Sheet thickness	0.025 mm	0.20 mm
Number of laminated sheets	20	1

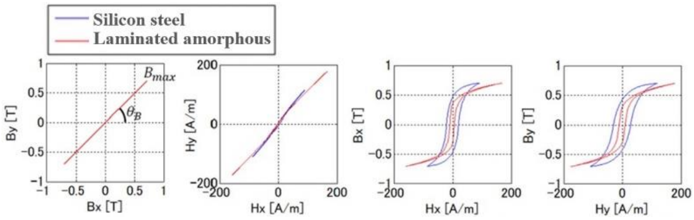

Figure 1: Vector magnetic properties of silicon steel and laminated amorphous in B_{max}=1T, α=0, θ_B=45°, f=50Hz.

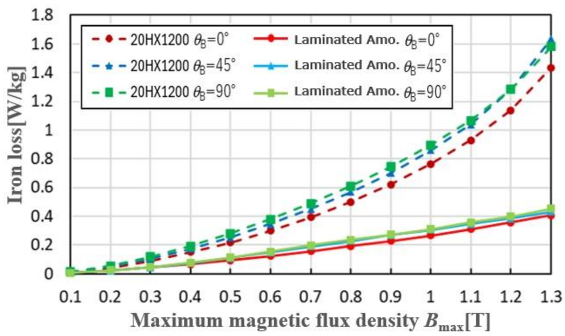

Figure 2: Relation between iron loss and maximum magnteic flux density B_{max} in α=0, θ_B=0°, 45° and 90°, f=50Hz.

α is the axial ratio and θ_B is the inclination angle of the maximum flux density B_{max} from the *x*-direction of the measurement samples. α=0 means the alternating flux density condition. Amorphous materials are laminated with the roll direction aligned in *x*-direction, rolling direction of silicon steel is also set to the *x*-direction. As shown in Fig. 1, laminated amorphous has a higher magnetic field strength than silicon steel, but the coercive forces of laminated amorphous are smaller than those of silicon steel in both *x*- and *y*-components of *B-H* loops. Fig. 2 shows the iron loss characteristics of both samples. In B_{max}=1.3 T, the iron loss of laminated amorphous is less than one-third that of silicon steel, indicating that amorphous sample have low iron loss even after impregnated adhesive lamination. In addition, the laminated amorphous shows little difference in iron loss with different inclination angles θ_B, indicating that it is a less anisotropic material.

References

[1] S. Ueno, T. Todaka and M. Enokizono, *IEEE Trans. Magn.*, vol. 47, no. 10 (2011), 3188-3191.