Effect of laser welding on magnetic properties of EDM-cut and laser-cut laminated cores from non-oriented electrical steel sheets

Yuji Tsuchida[a], Kosuke Otsuka[a], Taiki Mine[a]

[a] *Oita University, Oita, Japan.*

In this paper, we evaluated the magnetic properties of ring-shaped laminated cores manufactured by laser welding, based on the *B*-*H* curves and iron losses to reduce the losses of electrical motors. First, it was seen that the magnetic properties of the laminated cores with laser welding at four areas were better than those of the non-welded ones. Therefore, we investigated different laser welding and cutting conditions when laminating the cores. As a result, it was found that at 50 Hz and 1.4 T, the iron losses of the laser-cut and laser-welded laminated core were about 6 % to 8 % lower than those of the non-welded laminated core.

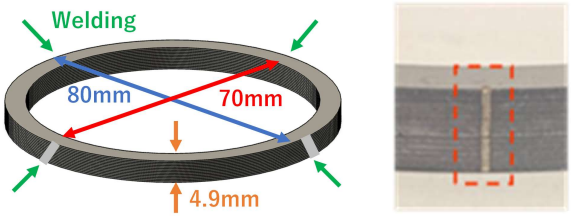
Keywords: laser welding, laminated cores, iron losses, electrical motors

1. Introduction

Generally, laminated cores are used in motors. Laminated cores are made by stacking mechanically processed electrical steel sheets. However, it has been shown that residual stresses generated during this manufacturing process degrade the magnetic properties of the laminated cores. During mass production, laminated cores are mainly made by stacking electrical steel sheets after punching them and then stacking them by caulking. On the other hand, in motor prototyping, laminated cores are mainly cut by laser and then laminated by laser welding. Differences in the manufacturing of laminated cores between motor prototyping and mass production have resulted in differences in the degree of degradation of the magnetic properties of laminated cores, causing difficulties in the development of new motors. Therefore, it is necessary to clarify the effects of cutting and stacking on the magnetic properties. Focusing on the cutting and stacking at the prototype stage, there have been no reports on the effects of laser welding on the magnetic properties of laminated cores [1, 2]. Therefore, we investigated the magnetic properties of laminated cores fabricated using EDM and laser as cutting and laser welding as stacking.

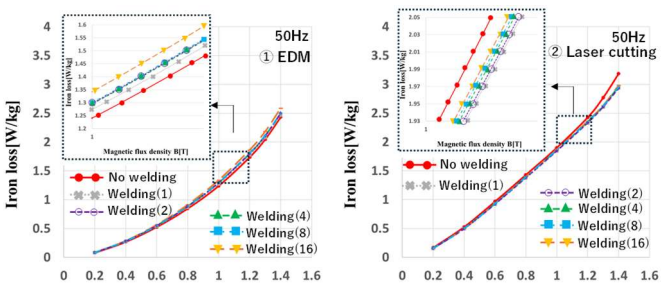
2. Laminated cores, results and discussion

Ring-shaped laminated cores with a thickness of 4.9 mm were fabricated from non-oriented electrical steel sheets with a thickness of 0.35 mm, an outer diameter of 80 mm, and an inner diameter of 70 mm as shown in Figure 1 (a). Laminated Core-A was cut by EDM and welded by laser, and Laminated Core-B was cut by laser and welded by laser. For both cores, 1, 2, 4, 8, and 16 areas were joined by laser welding. Figure 1 (a) shows the one in the case of 4 welding areas, and Figure 1(b) shows the enlarged welding area. The effects of thermal stress caused by laser welding on the magnetic properties were investigated according to the number of welding areas. For the Core-A, the iron loss becomes larger at one laser welding than that at no welding, and the iron loss is the largest at 16 as shown in Figure 2 (a). This is considered to be due to the thermal stress caused by laser welding, since the magnetic properties generally do not change much after EDM cutting. And for the Core-B, the iron loss decreases at one laser welding, and the magnetic properties are improved as shown in Figure 2 (b). Unlike Core-A, the iron losses of Core-B are considered to have been improved because the thermal stress-affected zone during laser cutting was mitigated by the laser welding. The iron loss increased in the Laminated Core-A, however, decreased by about 7% in the Laminated Core-B. Details of the iron losses and its discussion will be presented in the full paper.



(a) Laminated core (b) Welding area

Figure 1: Laminated core specimen and welding area.



(a) Core-A (b) Core-B

Figure 2: Iron losses of laminated cores made by Laser welding after EDM cutting and laser cutting.

References

[1] A. Schoppa, J. Schneider, C. D. Wuppermann, and T Bakon, Journal of magnetism and magnetic materials, **254-255** (2003), 367-369.

[2] H. Wang, Y. Zhang, and S. Li, Journal of Materials Processing Technology, **230**, (2016), 99-108.

Acknowledgements: This work was partially supported by Tsugawa Foundation. The author would like to show my gratitude for this support.