Effect of grain size on iron loss of Fe-3%Si under compressive stress

Yoshiaki Zaizen[a], Tomoyuki Okubo[a], Takeshi Omura[a] , Yoshihiko Oda[a] , Soichiro Yoshizaki[a],

Daisuke Miyagi[b]

[a] *JFE Steel Corporation, Japan,* [b]*Chiba University, Japan.*

The relationship between iron loss and grain size under compressive stress in non-oriented electrical steel sheets was investigated. It was found that the increase in iron loss due to compressive stress was smaller in materials with smaller grain sizes. The increase in hysteresis loss due to compressive stress was larger in materials with smaller grain sizes, while an increase in eddy current loss due to compressive stress was observed in materials with larger grain sizes.

Keywords: Non-oriented electrical steel sheet, iron loss, compressive stress, hysteresis loss, eddy current loss

1. Introduction

Non-oriented electrical steel sheets are widely used as iron core materials for motors and generators. The magnetic properties of electrical steel sheets are generally measured under stress-free conditions, but in compressor motors for air conditioners, etc., the stator cores are fixed by shrinking, and the electrical steel sheets are used under compressive stress of several 10 to 100 MPa. Therefore, it is important to evaluate the iron loss of electrical steel sheets under compressive stress.

Since the influence of material factors (Si content, sheet thickness, grain size) on the magnetic properties of non-oriented electrical steel sheets is significant, it is important to clarify the influence of those factors on the increase in iron loss under compressive stress. In previous studies, there have been few reports on the relationship between material factors and iron loss under compressive stress [1] [2]. Therefore, we report the results of our investigation of the effect of grain size on iron loss of electrical steel sheets under compressive stress.

2. Results and discussion

Materials with a thickness of 0.30 mm and grain sizes of 33 to 143 μm were prepared in the laboratory from 3 mass% Si material, and 30 mm wide samples were cut from the material. Magnetic measurements were made using a double yoke single sheet tester, and iron loss was measured by applying compressive stress to the specimen in the rolling direction.

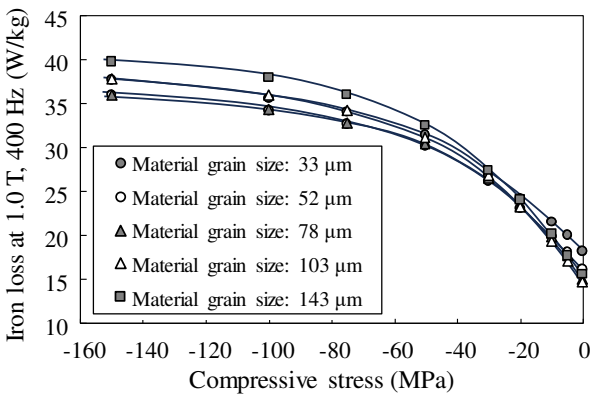

Figure 1: Effect of grain size on iron loss under compressive stress.

Figure 1 shows the dependence of iron loss on compressive stress in materials with different grain sizes. The results show that iron loss increases significantly when compressive stress is applied, even at low stresses of a few MPa and increases approximately 2 to 2.4 times under compressive stress of 100 MPa compared to the stress-free condition. Figure 2 shows the effect of grain size on the increase in iron loss due to compressive stress. The increase in iron loss is calculated by subtracting the iron loss without stress from the iron loss with compressive stress of 100 MPa. The results show that the increase in iron loss due to compressive stress is dependent on the grain size, and iron loss is smaller in materials with smaller grain sizes. Materials with smaller grain sizes show a larger increase in hysteresis loss due to compressive stress, while those with larger grain sizes show an increase in eddy current loss due to compressive stress. Since only the grain size of this material was changed and the specific resistance and sheet thickness were the same, it was suggested that abnormal eddy current loss increased due to compressive stress.

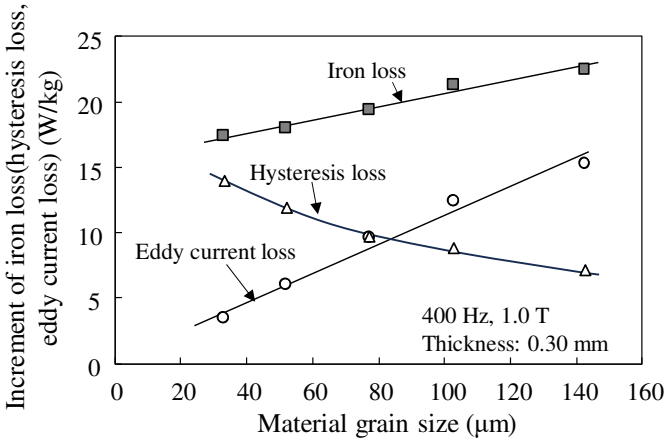

Figure 2: Relationship between grain size and hysteresis loss and eddy current loss under compressive stress (100 MPa).

References

[1] Y. Oda, et al., IEEE Trans. Magn. 50 (2014), 2002304.
[2] K. Senda, et al., IEEJ Trans. FM. 131 (2011), 884-890.