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Effect of Phosphorus on the Magnetic Properties of Non-oriented Electrical Steel Containing 3.2 wt% Silicon

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The effect of phosphorus on the microstructures and magnetic properties of non-oriented electrical steels containing 3.2 wt% silicon was investigated. Specimens with different phosphorus contents were made, and then, with various temperatures, hot band and cold rolled sheets were annealed so as to study its effect on microstructures, such as grain size and re-crystallization texture, by using EBSD (Electron Backscattering Diffraction) and X-ray Pole figure. Continuously, for only considering the texture effect of phosphorus, hot band and cold rolled sheets were annealed to have same grain size. The findings showed that the addition of phosphorus could improve texture and magnetic properties. However, it is likely that the addition of phosphorus is not always recommended due to its strong effect to the grain growth stagnation. Moreover, the change of texture and magnetic property was discussed based on relationship between the shear band and phosphorus.

Keywords: Non-oriented electrical steel; Core loss; Shear band; Grain size; Texture

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Development of Electron Beam Focusing Magnet in High Power Klystron Amplifier

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The focusing magnet in a relativistic klystron amplifier (RKA) focuses electron beam to intensify beam power and to prevent electron beams colliding to wall of accelerating tube by producing Lorentz force as shown Fig. 1

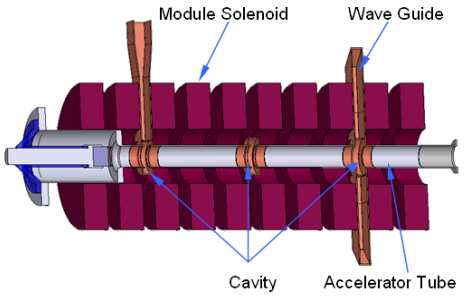

Fig. 1. Concept of beam focusing magnet.

The nominal magnetic field for electron beam focus is 1.0T and peak field is about 1.2T as DC field. Magnet was designed as modular type with 10 pan-cake style solenoids. The bore of module solenoid is as tight as possible to KA beam tube to increase focusing efficiency, so that all cavities are positioned between modules. 10 modules were integrated as big one solenoid by put spacers between modules same as module height, without loosing uniformity of axial field. This configuration makes it possible to remove thermal load efficiently as much as about 110 kW from Joule heating in coils. The center of the assembled focusing magnet with respect to the beam center was aligned with measured and estimated field data of the pan-cake solenoids, with specially designed measuring system, for e-beam not to be scattered. The error of magnetic field center and directional error of magnetic flux lines with respect to solenoid axis was less than 1.6mm and 3 radians, respectively as shown Table 1. To increase amplification efficiency at RKA, the flux lines around output cavity were optimized with computer simulation by shaping iron yoke with e-beam dynamics.

Table 1. Data for magnet alignment.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Incline [Degree]	0.12	0.11	0.12	0.21	0.06	0.24	0.03	0.31	0.05	0.06
Direction [Degree]	70.4	72	17	32	249	339	134	320	165	200
Off axis [mm]	0.83	0.84	1.07	1.66	0.86	1.52	0.61	1.3	0.47	0.78
Offset direction [Degree]	6.27	9	107	340	74	18	139	12	120	202

This work is supported by ADD as research project.