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**Developments of Grain-Oriented Silicon Steel Sheets with Low Iron Loss**

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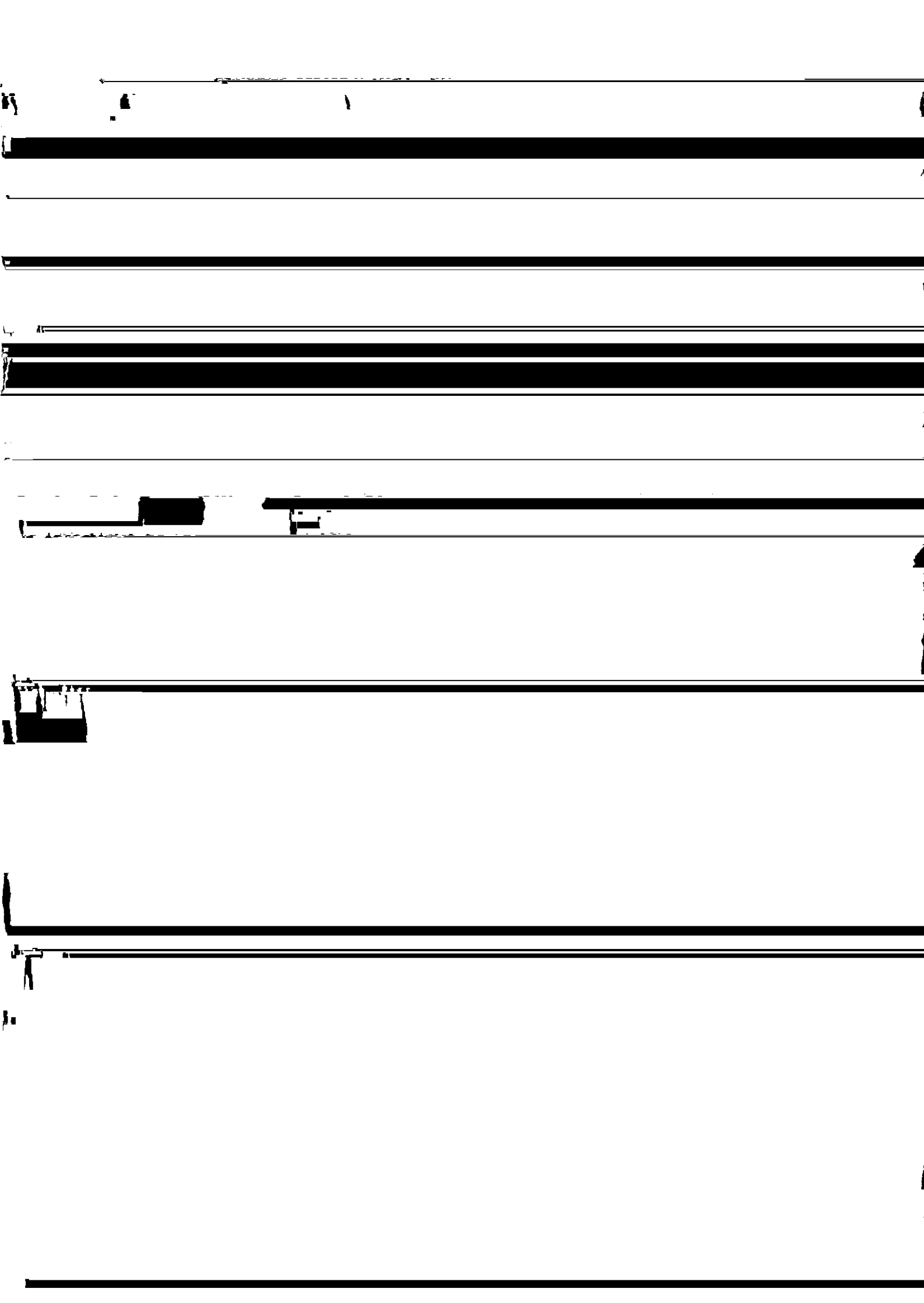
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**Synopsis :**

Two approaches for reducing iron losses in grain oriented Si-steel sheets were described. One is a metallurgical approach with reduces sheet thickness, increases Si content, and optimizes grain diameter without deteriorating texture orientation. Increase in C content, hot rolling at low temperature and low speed, and utilization of very fine carbides have been applied for that purpose. The other is a physical approach and is called the "domain refining technique". Plasma-jet (PJ) irradiation has been found to be effective for refining domain wall spacing without deteriorating surface coatings of sheets. PJ irradiation has enabled further loss reduction in thin gauge grain-oriented Si-steel sheets.

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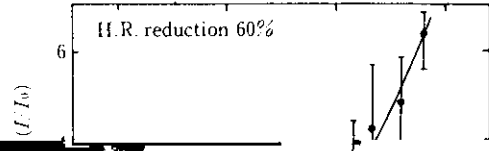
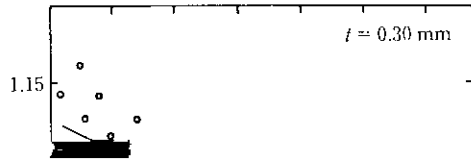
yen to 3 million yen per kilowatt. Because copper loss

crystal orientation. With this reduction in hysteresis

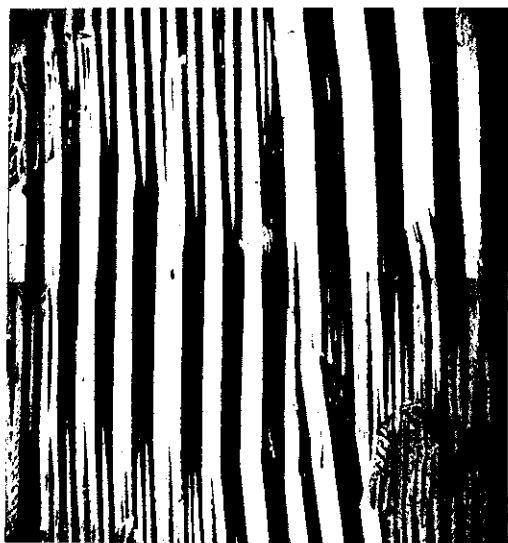
tion for copper depends on the ratio of loading; it is,

60% of iron loss, became proportionally more important,

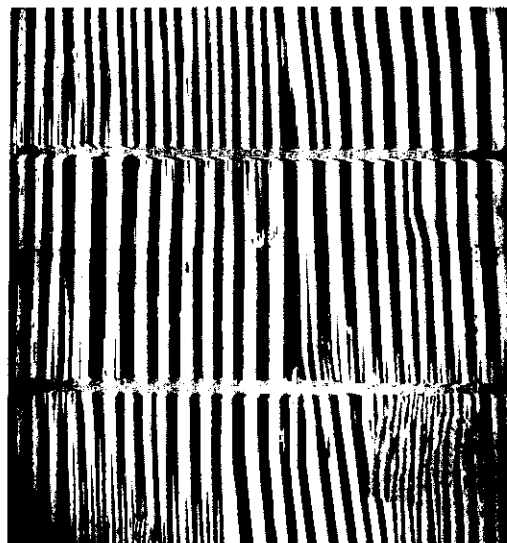
these points, eddy current loss can be reduced by reduc-







Before irradiation



After PJ irradiation

2 mm

Photo 1 Domain refining by PJ irradiation

thickness). It has been verified that iron loss reductions obtained by plasma jet irradiation are positively related to  $B_0$  value and that a maximum iron loss reduction of about 16% can be achieved. Further, the relationship

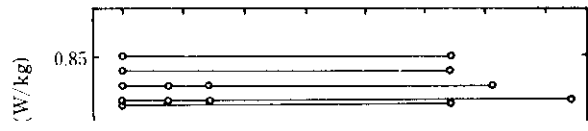




Table 1 Iron loss of model transformers

Sheets grade	Magnetic properties of sheets		Magnetic properties of model transformer cores			
			Conventional lap joint		Step-lap joint	
	$B_s$ (T)	$W_{17/50}$ (W/kg)	$W_{17/50}$ (W/kg)	B.F.	$W_{17/50}$ (W/kg)	B.F.
RGH	1.89	0.91	1.08	1.19	1.06	1.16

and results in reduced iron loss.

This type of steel sheet offers significant improvement in iron loss over that of conventional products, and by enhancing transformer efficiency is expected to make a major contribution to energy conservation.

**References**