

## Soft Ferrite Materials in Power Electronics

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Magnetic materials are roughly classified into metallic magnetic materials and oxide magnetic materials by their composition. And, by their magnetic properties, magnetic materials are also classified into soft magnetic materials having the smaller coercive force ( $H_c$ ) and hard magnetic materials having the large  $H_c$ . (figure 1)

Ferrites are well known as typical oxide magnetic materials. Since OP magnet and CuZn ferrite core were invented by Kato and Takei at 1930's, various kinds of hard/soft ferrites have been developed and used in many applications.

Soft ferrites are one of the important materials for power electronics, even today. Generally, the saturation magnetic flux densities of ferrite materials are smaller than that of metallic soft magnetic materials such as permalloy and silicon steel. However, because of their higher electrical resistivity, ferrites have superior magnetic properties at high-frequency. Therefore, soft ferrites have been widely used as the core of inductor and transformer for high-frequency.

MnZn ferrites and NiCuZn ferrites are well known as representative materials of soft ferrite.

Since these ferrites have different magnetic characteristics, suitable applications are different. For example, as shown in figure 2, appropriate operating frequency range is different by their different permeability range.

There are various magnetic materials, and even for only MnZn ferrite used as the core of transformer, there are many kinds of materials with different magnetic properties such as permeability, core loss and saturation magnetic flux density. Therefore, it is important to understand magnetic features of various magnetic materials to select suitable materials for applications.

On the other hand, it is becoming more and more important to consider actual operating condition and usage on recent development of magnetic materials.

In the presentation, the recent topic on the development of ferrite materials and its application examples in power electronics will be reported.

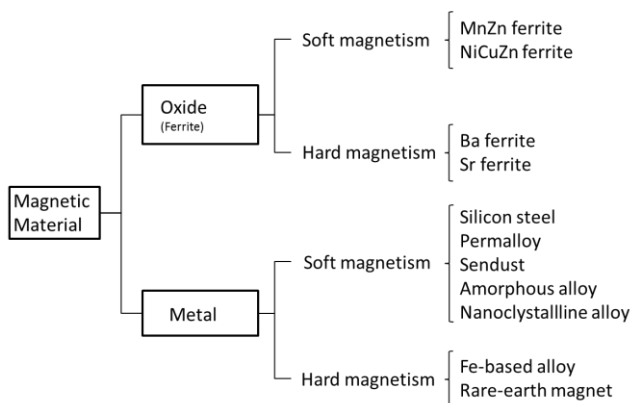


Figure 1. The classification of magnetic materials, and representative materials

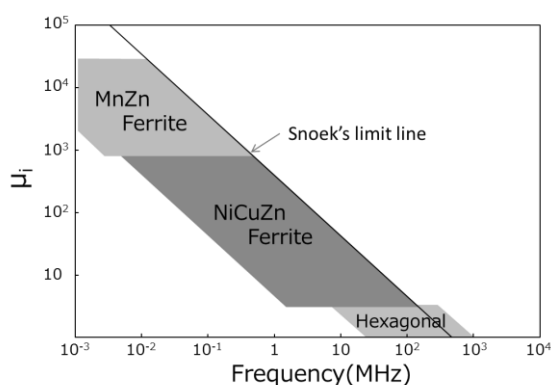


Figure 2. Schematic image of relationship between initial permeability range of ferrites and its appropriate operating frequency range.<sup>1)</sup>

### Reference

- 1) T.Hiraga: Ferrite (in Japanese), p.89 (Maruzen, Tokyo,1986)