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Soft Magnetic Materials

Applications

Powder metal soft magnetic alloys are used primarily in DC magnetic fields, as well as for many applications requiring a pulsed direct current. These alloys may also be suitable for some low frequency AC applications where core loss is not a critical concern. Typical applications include anti-lock brake system sensor rings, DC motor stators and armatures, and other DC flux path components.

Alloys

Starting with iron as the base material, additions of phosphorus, silicon, or nickel will enhance specific magnetic properties. Four basic materials include:

	Phosphorus	**Silicon**	**Nickel**
SSD-45P	0.45 %	-	-
SSD-80P	0.80 %	-	-
SSD-3Si	-	3 %	-
SSD-50Ni	-	-	50 %

- SSD-45P has a small phosphorus addition to improve sinterability and magnetic properties compared to plain iron.

- SSD-80P has an increased amount of phosphorus to aid densification and increase resistivity, further improving magnetic performance.

- SSD-3Si uses an addition of silicon to increase resistivity compared to the iron–phosphorus alloys, resulting in improved magnetic properties at the expense of ease of processing.

- SSD-50Ni has a large nickel addition that provides high magnetic permeability, offering improved magnetic response time compared to iron, iron-phosphorus, and iron-silicon alloys. This improvement in permeability is gained at the expense of lower magnetic induction and higher cost.

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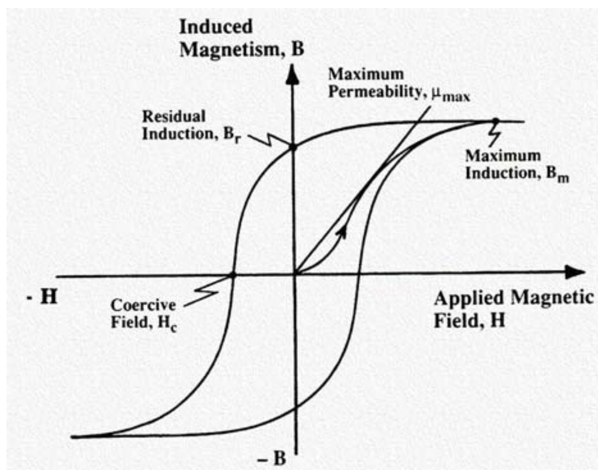
Processing Grades

One of the advantages of the powder metal process is the ability of the process to be tailored to specific application requirements. Two “grades” are described in this bulletin to illustrate the general performance that can be expected from these alloys. Grade ST (standard temperature) provides good magnetic properties with excellent dimensional control. Grade HT (high temperature) offers improved magnetic properties at the expense of slightly increased dimensional tolerances due to the shrinkage that occurs as a result of the high temperature sintering process. Coining, following by annealing, is an option for maximizing both dimensional control and magnetic properties.

Measurement of Magnetic Properties

Magnetic properties of the materials are characterized by the magnetic hysteresis curves of toroidal samples.

Saturation Induction, B_{max}, is the maximum value of induction in a DC current loop. It is the measure of how strongly a material can be magnetized. Achieving saturation usually requires a very large magnetizing force. For material comparisons, the induction is usually reported using a magnetizing force that will get close to, but fall short of, the true maximum induction. For example, B_{15} is the induction that is achieved with a magnetizing force of 15 Oe.



Remanence or Residual Induction, B_r, is the magnetic induction that remains after the magnetizing force has been removed.

Coercive Force, H_c, is the DC magnetizing force required to restore the magnetic induction to zero after the material has been magnetized. A low value of H_c is usually desired to minimize energy losses.

Maximum Permeability, μ_{max}, is the maximum value of the relative permeability achieved during the magnetization cycle. It is a measure of the magnetic responsiveness of the material. The higher the maximum permeability, the easier it is to magnetize.