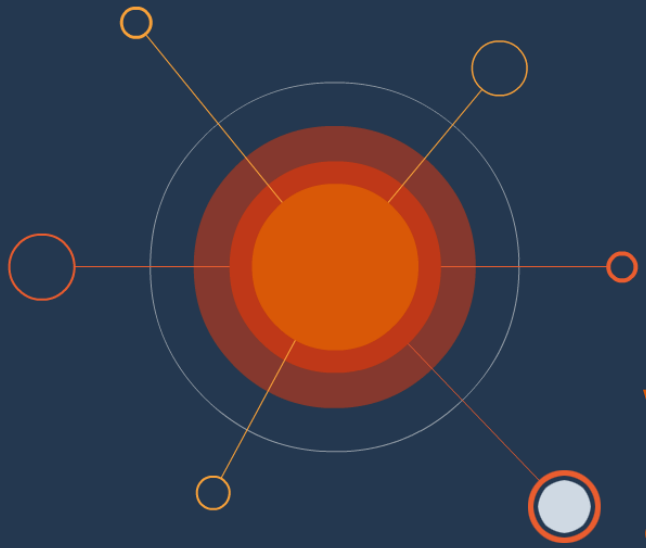

SISRAM

VAC materials for electric motors and generators

ing. Marco Tosini

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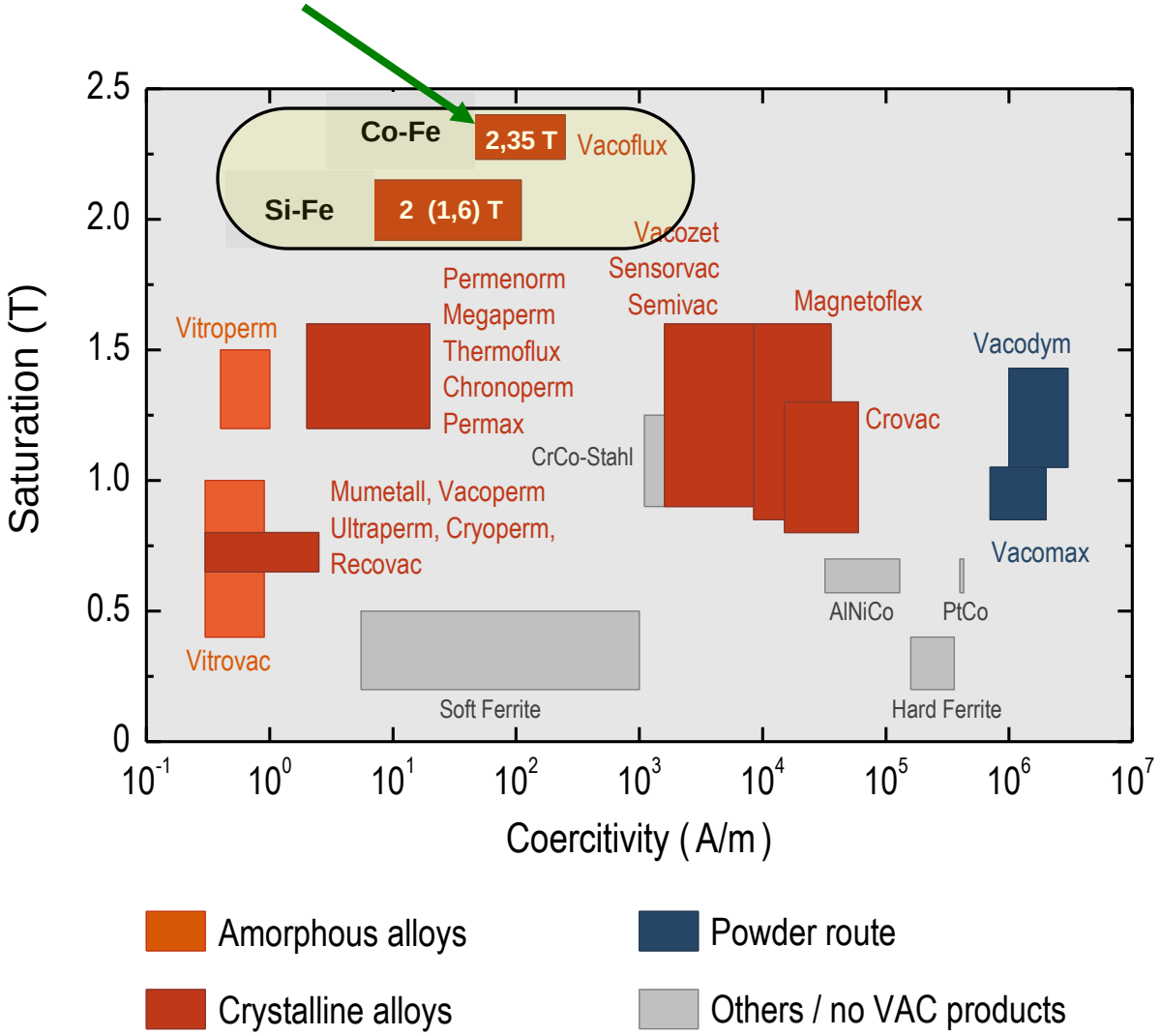
VACUUMSCHMELZE

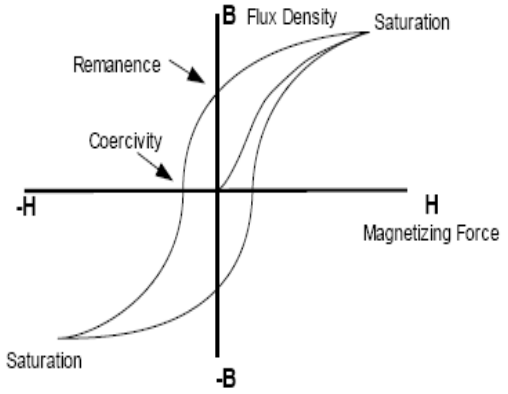
Vacuumschmelze GmbH & Co.KG, Hanau

World of magnetic materials



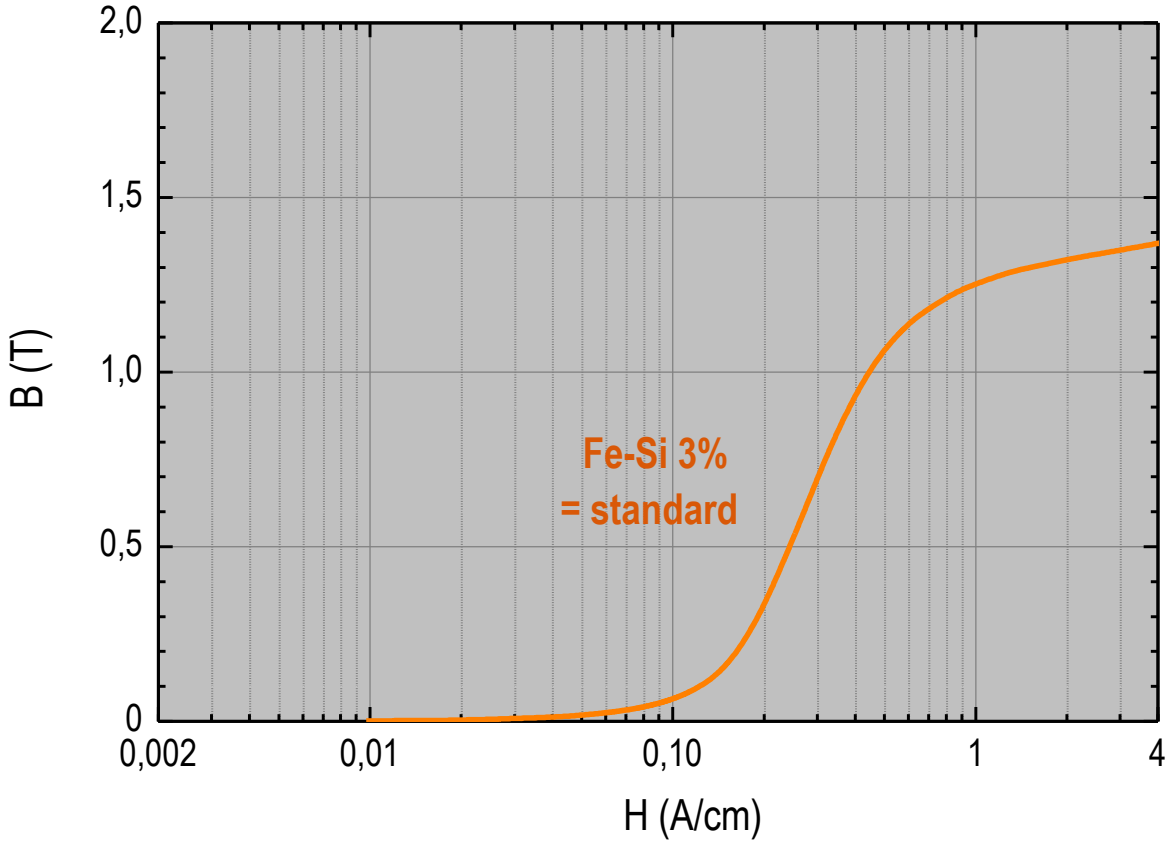
VACUUMSCHMELZE

offers for wide-spread applications the optimum advanced materials!



Magnetic materials for electric motors & generators – an overview

Static virgin curve



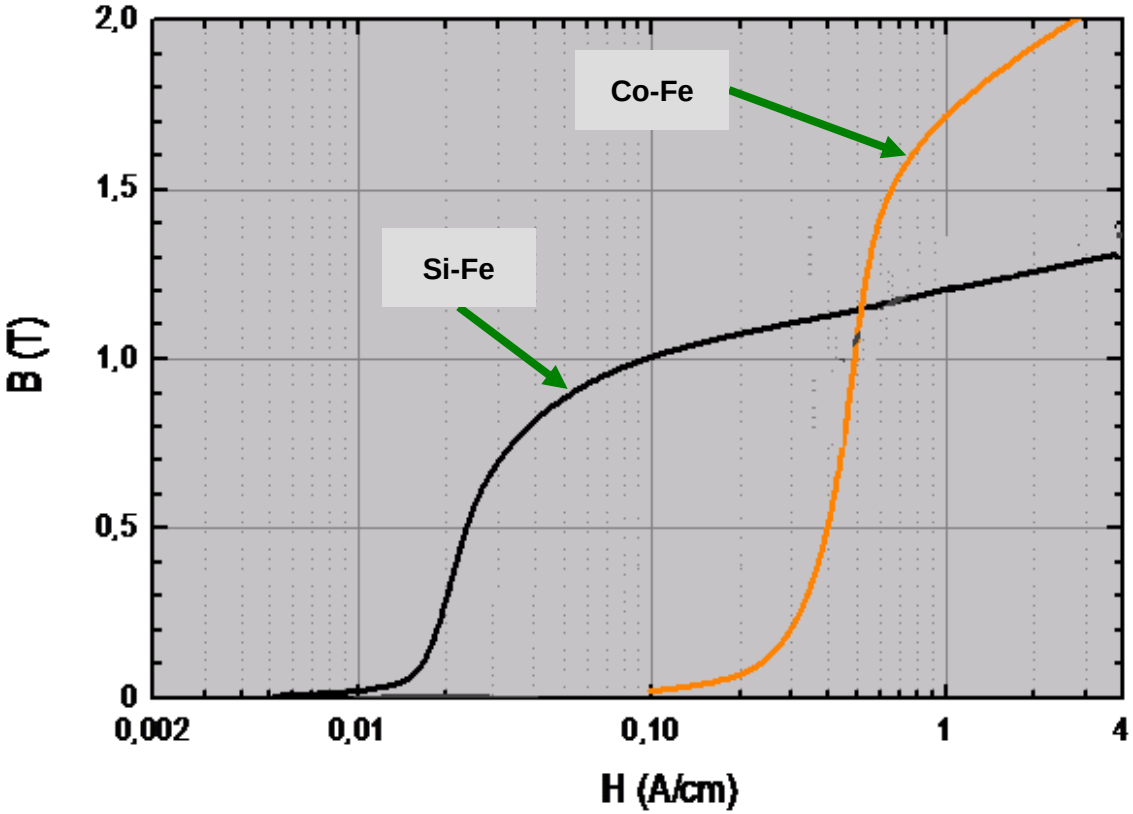
Electric Steel

Fe-Si 3%

"All-in-one material suitable for every purpose" ???

Magnetic materials for electric motors & generators – an overview

Static virgin curve



Electric Steel

Fe-Si 3%

49% Cobalt-Iron

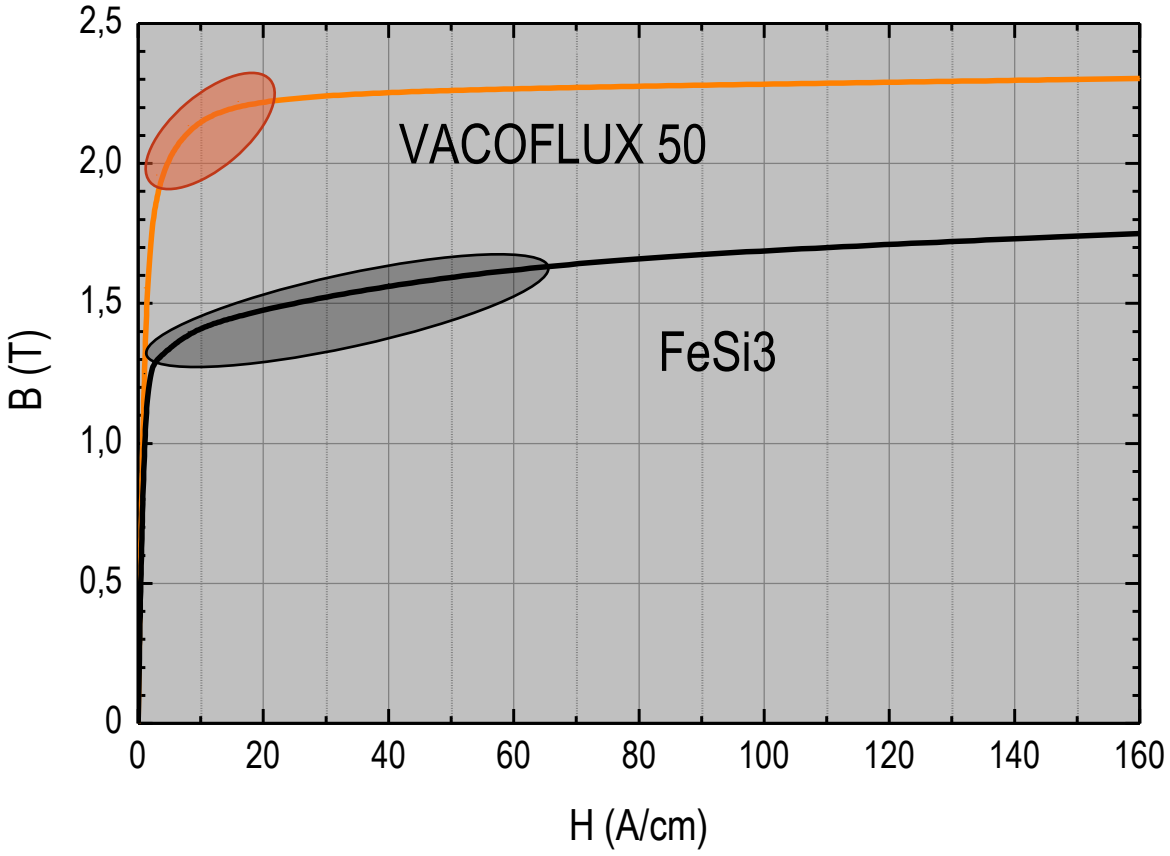
VACOFLUX© 50

maximum available saturation induction!

Cobalt-Iron Materials

Highest saturation induction (B_S) for maximum magnetic force F:

$$F \sim B^2$$



VACOFLUX© 48/50

Core material for maximum energy density in electric motors!

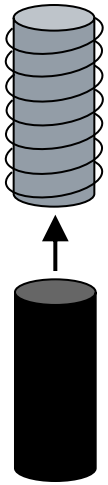
Energy density in electric motors & generators

Co-Fe material for maximum magnetic force F: $F \sim B^2$

Example: electric coil ⇒ magnetic field H = 16 A/cm

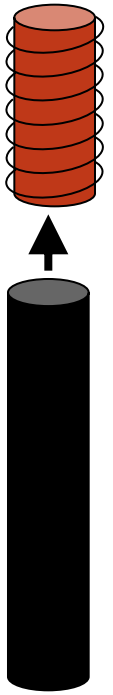
Core of
Fe-Si 3% (standard)
B_{16} = 1.46 T
magnetic force

Load: 100%

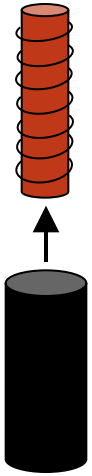


Core of
VACOFLUX© 50
B_{16} = 2.22 T
magnetic force

Same dimension of
Core: **+ 132% Load**



or



Load (100%):
- 60% Core volume

Co-Fe Alloys for electric motors & generators vs. Fe-Si 3%

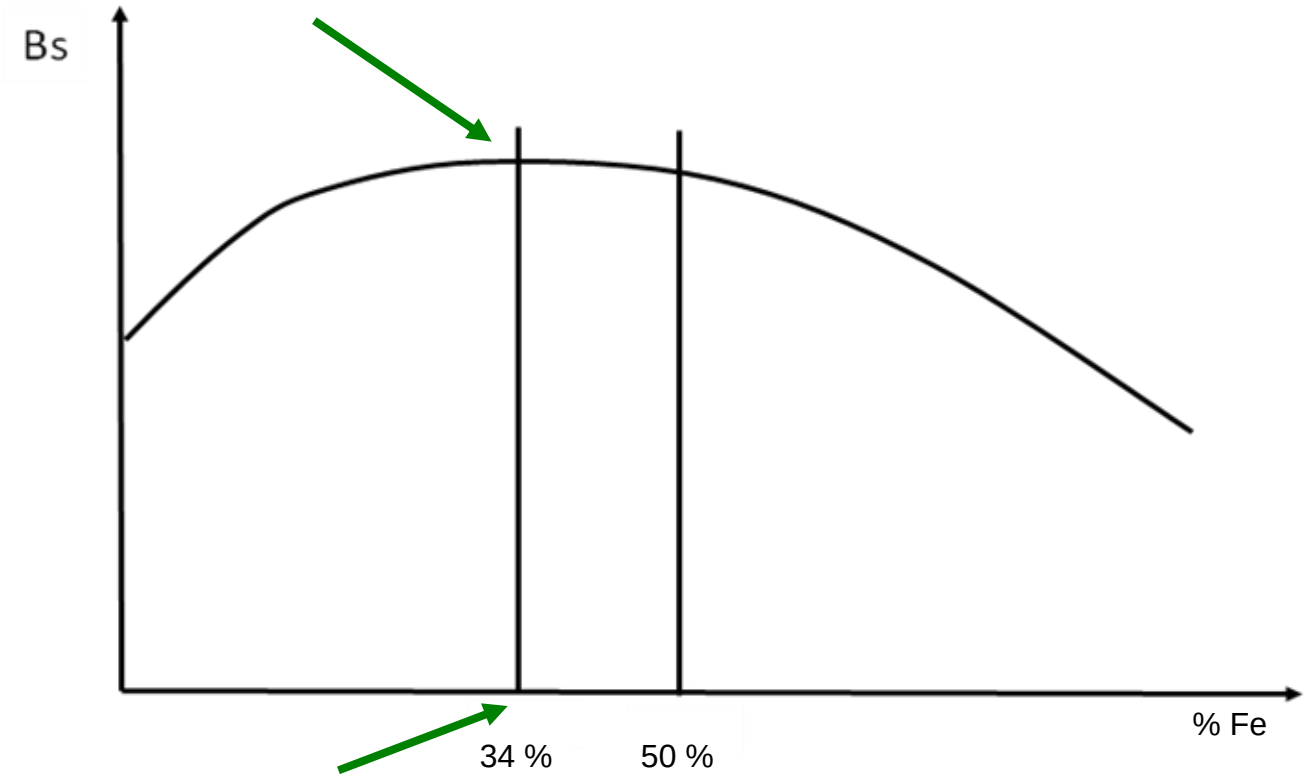
Material	Coercive force H_C (A/cm)	Electric resistivity ρ_{el} ($\mu\Omega$m)	Saturation polarization J_S (T)	Induction at 16A/cm (T)
Fe-Si 3%	0.2	0.4	2.03	1,45
VACOFLUX© 50	< 0.8	0.4	2.35	2.2
VACODUR© 50	< 2	0.4	2.3	2.0

Typical dynamic properties of cold rolled material, measured at toroidal cores, material thickness 0.35mm
All dimensions are typical values, details can be found in the VAC leaflet PHT001.

Co-Fe Alloys… curiosities:

The alloy composition which has the absolute maximum induction saturation (Bs) is :

34% Iron
66% Cobalt

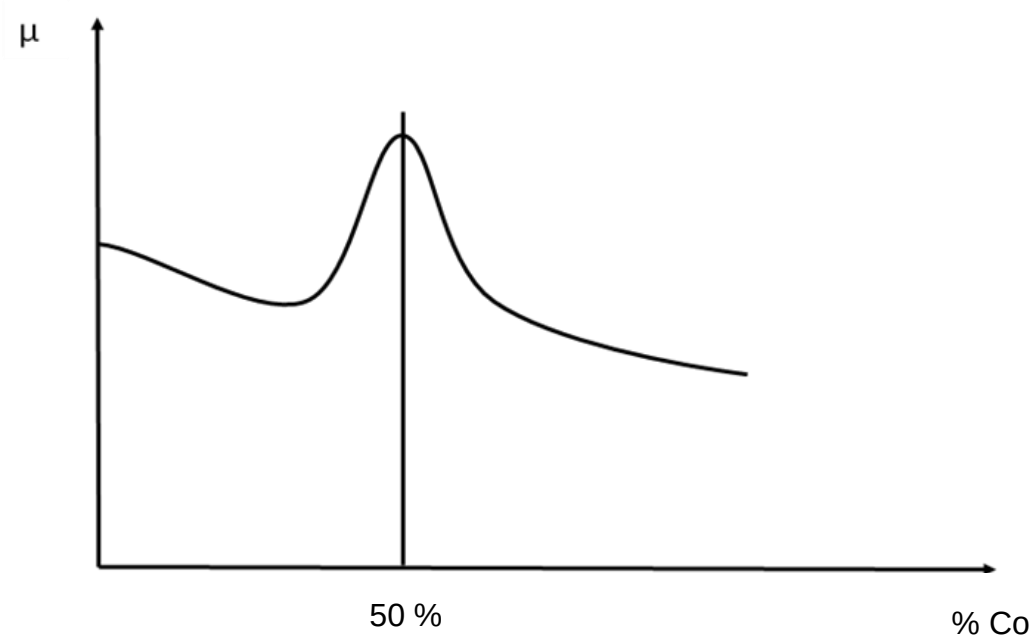


Co-Fe Alloys… curiosities:

This alloy (34 % Fe 66 % Co), however, is not pratically used since it would have a low permeability and a high coercive force that would lead to high losses.

The best compromise from the magnetic point of view would be reached with an alloy made with 50% cobalt and 50% iron.

This alloy would have a remanence induction (B_s) slightly lower than the previous one while its permeability and coercive force would be better.



Co-Fe Alloys… curiosities:

Unfortunately, also this alloy (50% cobalt and 50% iron) can not be pratically used because it would be very fragile and hardly reworkable.

It would also have a low resistivity and conseguentely high eddy currents (in alternate current).

Due to these problems, let's now consider the BEST COMPROMISE:

An alloy made up of:

49% cobalt e 49% iron 2% vanadium

This alloy has an excellent saturation, slightly lower than the previous one (2.35 T), a good permeability, low coercive force, good ductility, and therefore reworkability, and an high resistivity. This alloy provides the best technical compromise and is that one universally used.

Vac proposes:

Vacoflux 50

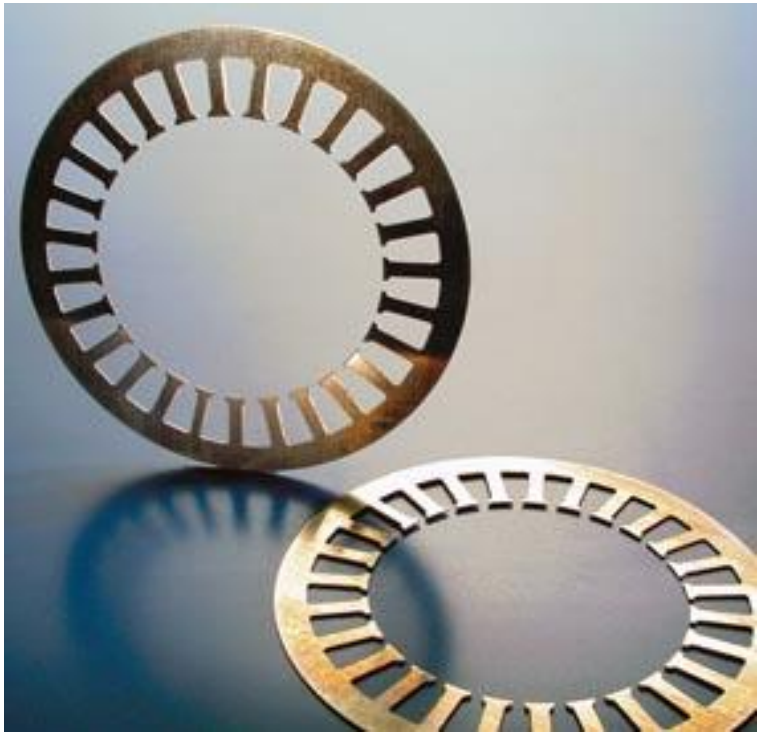
High coercitivity (0,7 - 1,4 A/cm) depending from thickness, high initial permeability, maximum permeability around (1000 -12.000).
It is not usually provided as a tape but only in finished parts.
This alloy is suitable for static applications.

Vacoflux 48

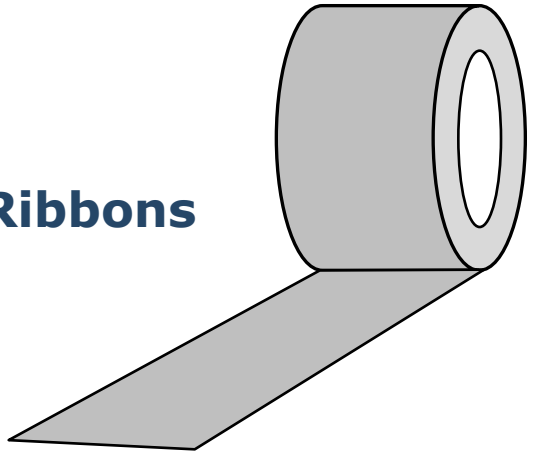
Low coercitivity (0,3 A/cm) . The initial and maximum permeability are higher than Vacoflux 50 (1200 – 20.000).
This alloy is suitable for dynamic applications.

Form of supply:

Laminations



Ribbons



Vacstack

Low Cobalt content alloys:

Vacoflux 17

Vacoflux 17

This is a 17% cobalt alloy. It's cheaper than the alloys with an higher cobalt percentage and it has an higher Saturation (2,22 T) if compared to Si-Fe.

Permeability is good (600 – 4000) while, unfortunately, the coercitivity is quite high (1,5 A/cm).

This leads to relevant losses if the material is used in dynamic applications.

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