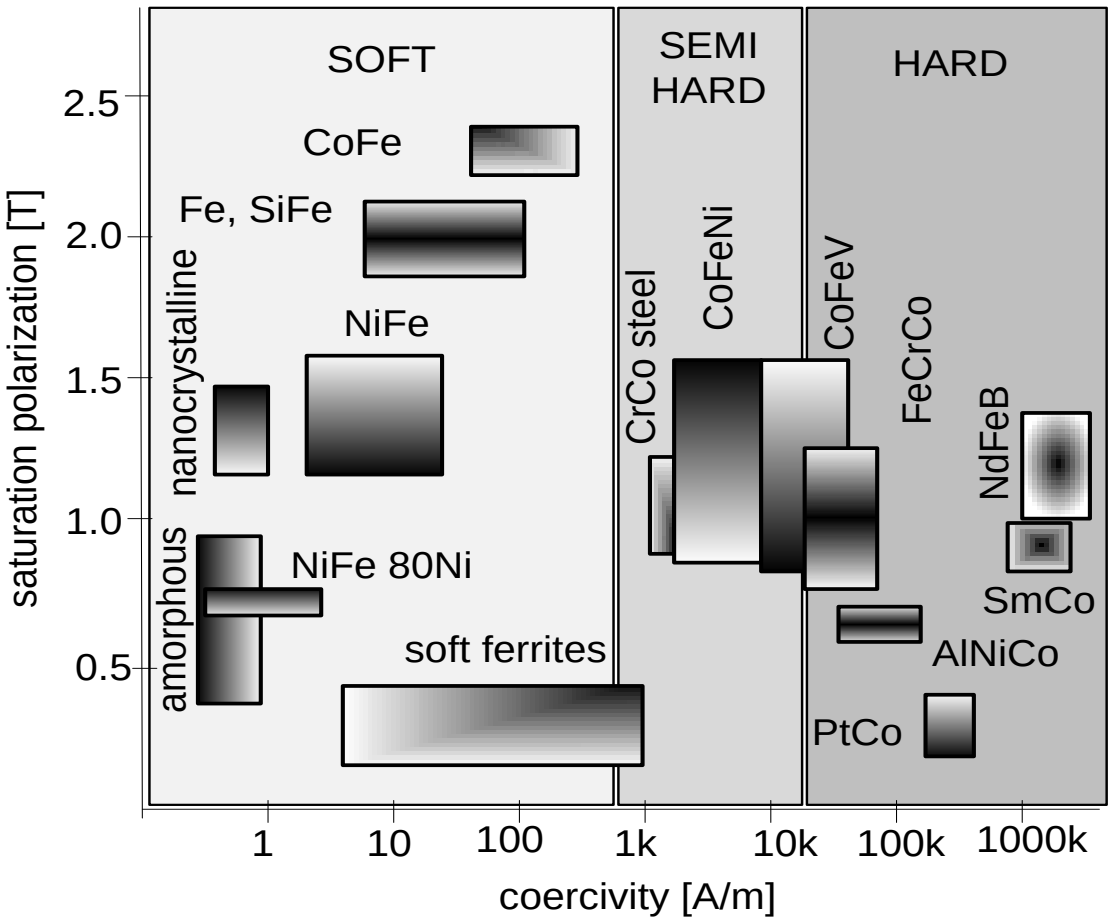
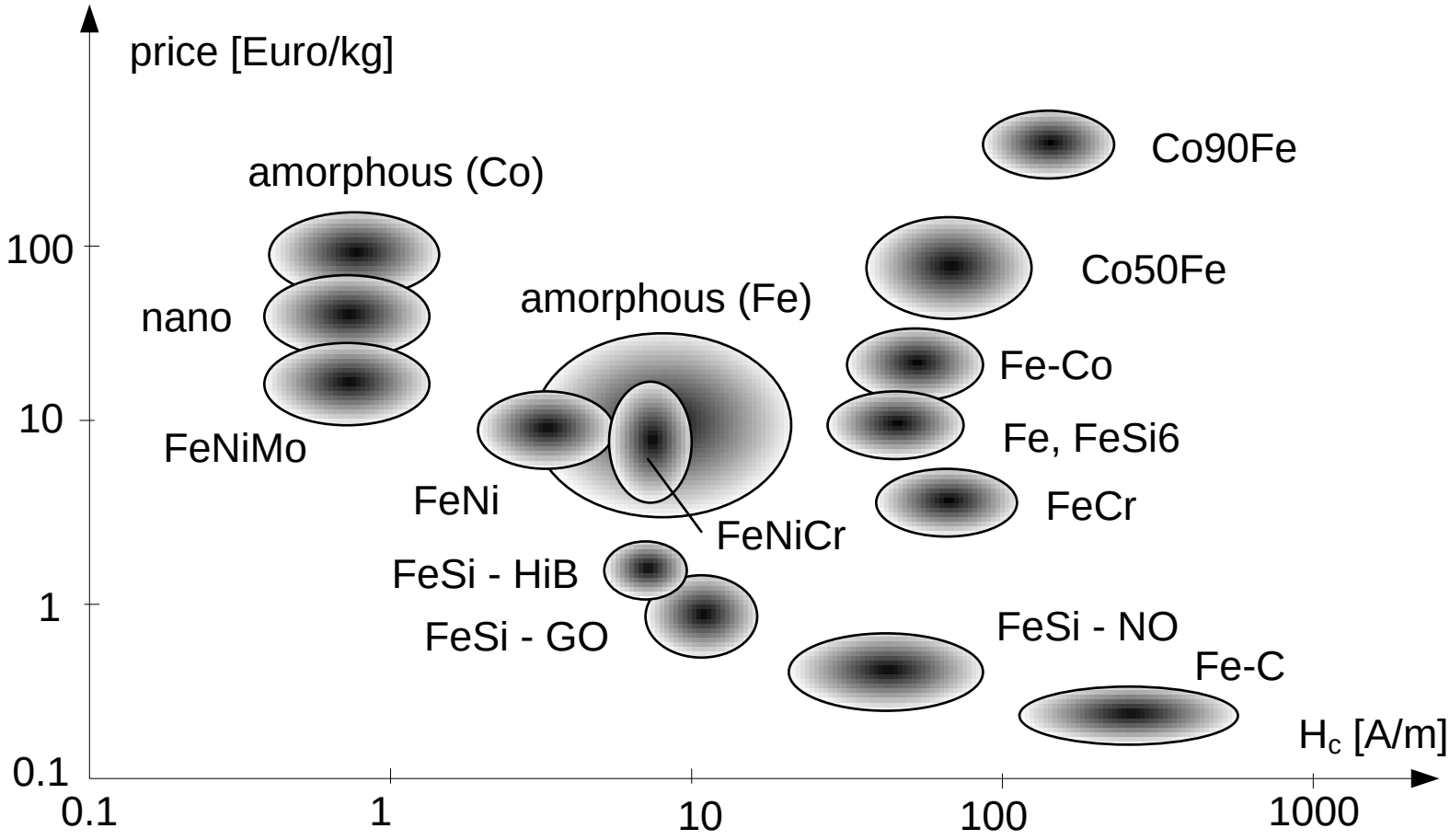
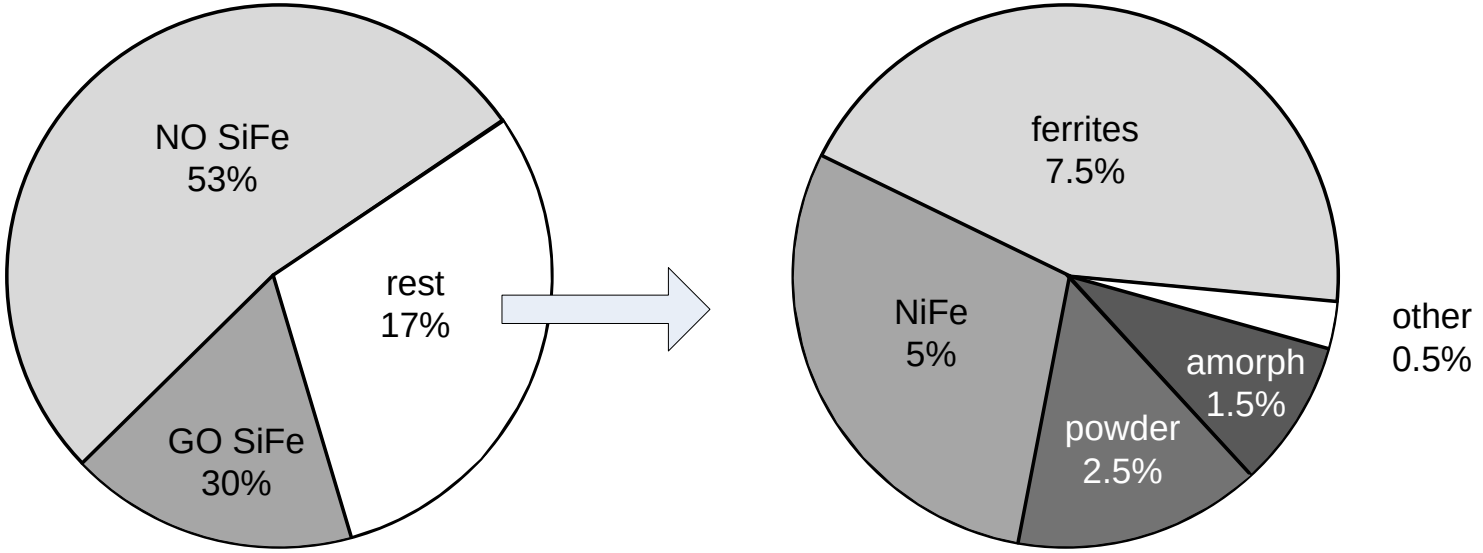
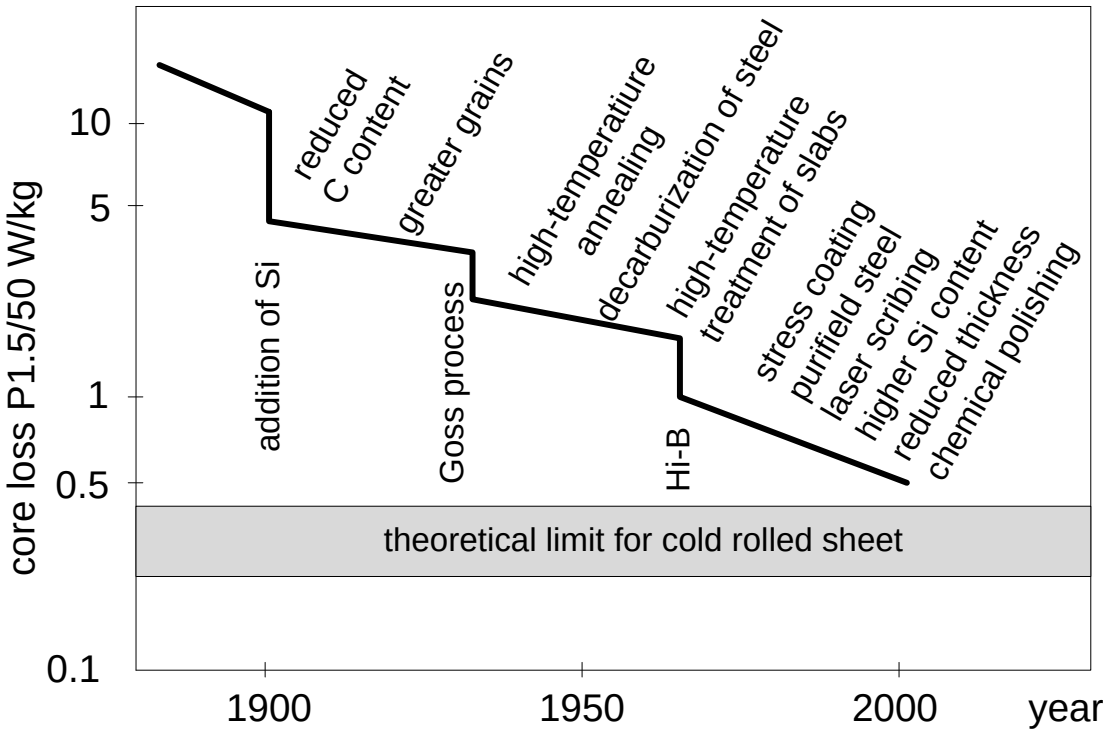

SOFT
SEMI HARD
HARD
CoFe
Fe, SiFe
NiFe
nanocrystalline
amorphous
NiFe 80Ni
soft ferrites
CrCo steel
CoFeNi
CoFeV
FeCrCo
NdFeB
SmCo
AlNiCo
PtCo
saturation polarization [T]
2.5
2.0
1.5
1.0
0.5
1
10
100
1k
10k
100k
1000k
coercivity [A/m]

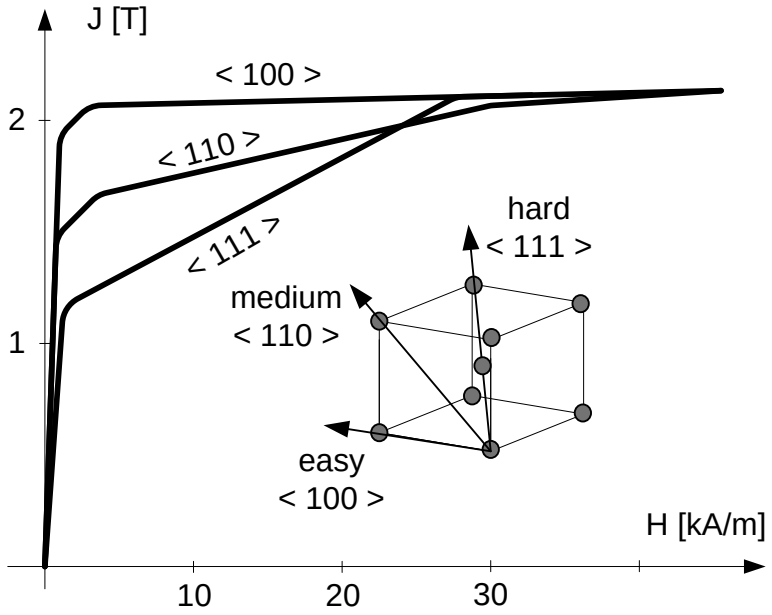

price [Euro/kg]
100
10
1
0.1
0.1
1
10
100
1000
H_c [A/m]
amorphous (Co)
nano
FeNiMo
amorphous (Fe)
FeNi
FeNiCr
FeSi - HiB
FeSi - GO
Co90Fe
Co50Fe
Fe-Co
Fe, FeSi6
FeCr
FeSi - NO
Fe-C

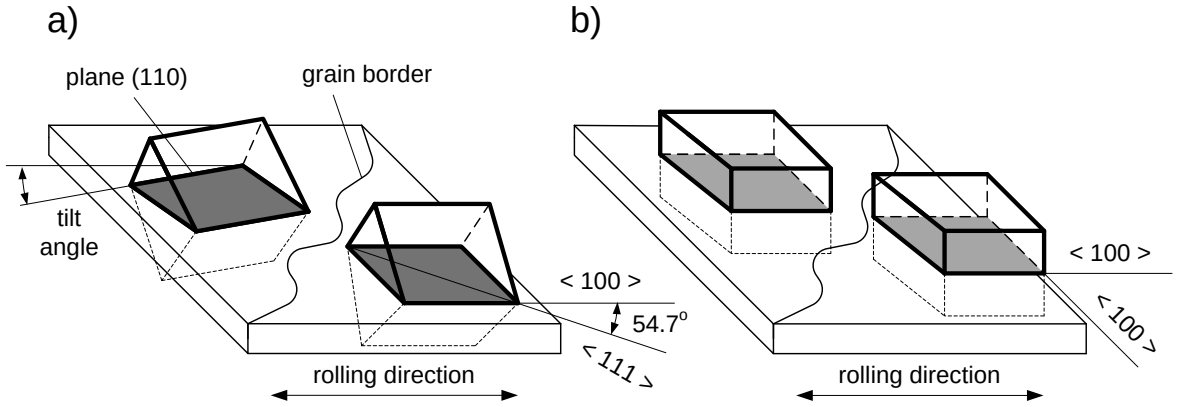

NO SiFe
53%
rest
17%
GO SiFe
30%
ferrites
7.5%
NiFe
5%
amorph
1.5%
powder
2.5%
other
0.5%

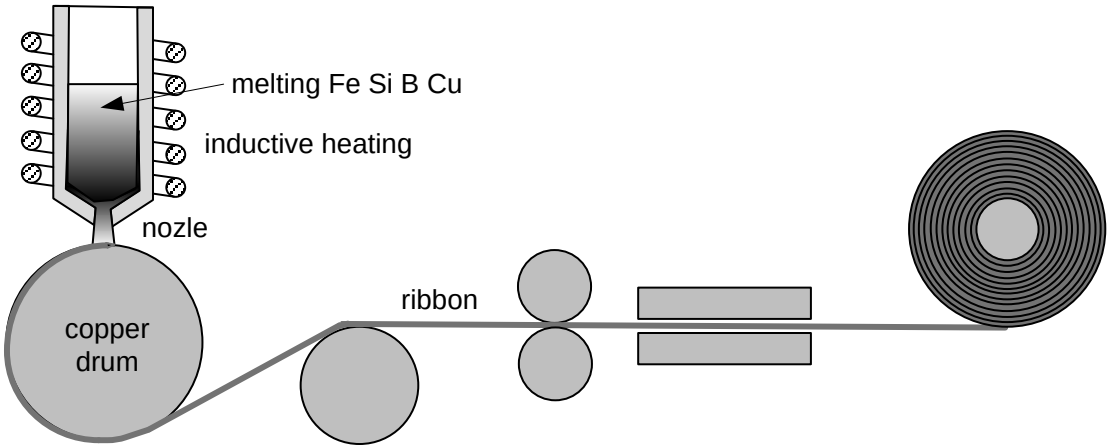
Parameter	3% SiFe GO	FeSiB Metglas	Ni80Fe20 Permalloy	Co50Fe50 Permendur	MnZn Ferrite
B_s [T]	2.03	1.56	0.82	2.46	0.2 - 0.5
H_c [A/m]	4 - 15	0.5 - 2	0.4 - 2	160	20 - 80
P1.5T/50Hz [W/kg]	0.83	0.27		1	
P 1T/1kHz [W/kg]	20	5	10	20	
μ_{max} $\times$ 1000	20 - 80	100 - 500	100 - 1000	2 - 6	3 - 6
Frequency range [kHz]	3	250	20	up to 1 kHz	2000 NiZn - 100 000



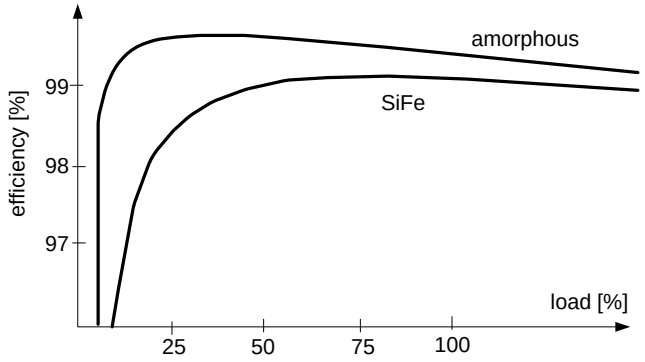
Losses are an important parameter of electrical steel. The grades of electrical steel (and of course its price) strongly depends on loss. The loss is mainly dissipated as heat thus it is wasted energy. Although efficiency of modern power transformers is as high as 99% it is estimated that annual losses of energy just in the UK are equivalent to about $7 \cdot 10^6$ of barrels of oil, what is equivalent to about 35 000 ton of SO_2 and $4 \cdot 10^6$ ton of CO_2. It is estimated that annual magnetic core losses in the US amount to nearly 45 billion kWh costing about 3 billion dollars. [Moses 1990, Moses 2004].

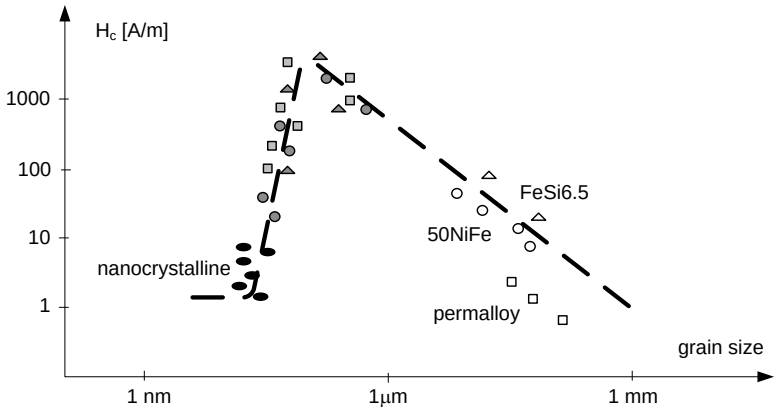

J [T]
< 100 >
2
< 110 >
< 111 >
hard
< 111 >
medium
< 110 >
1
easy
< 100 >
H [kA/m]
10
20
30

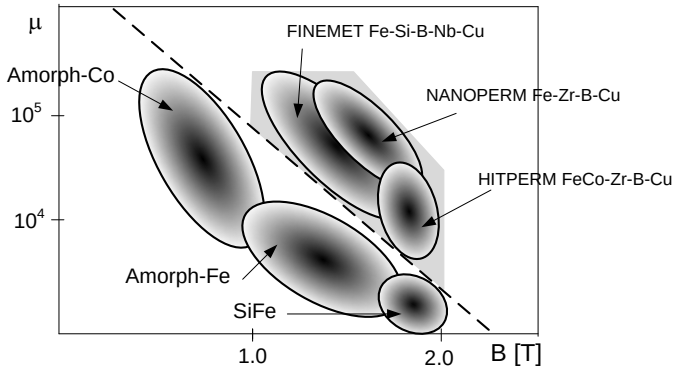

a)
b)
plane (110)
grain border
tilt
angle
< 100 >
54.7°
< 111 >
rolling direction
< 100 >
< 100 >
rolling direction

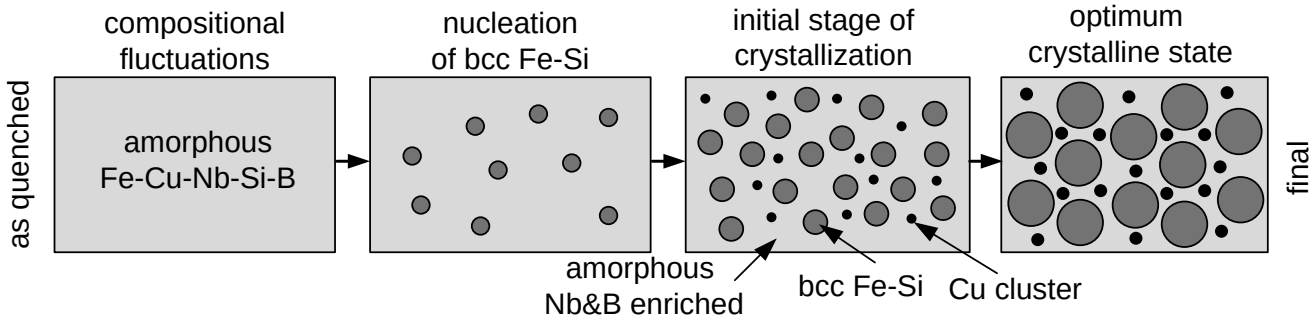


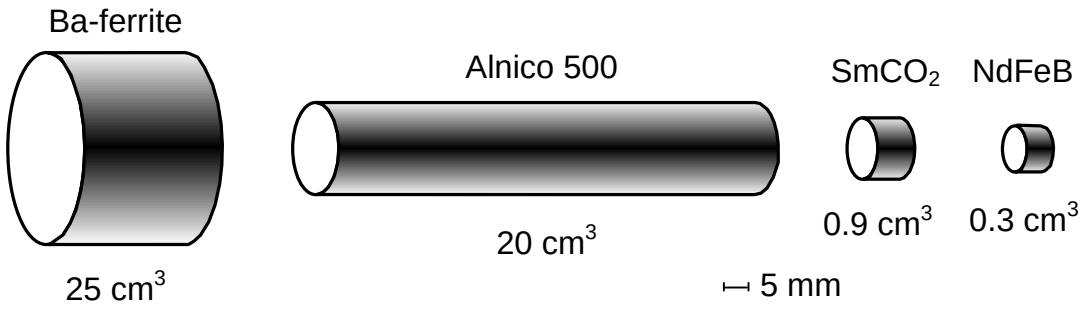
		J_s [T]	$\mu_{max} \times 1000$	$\lambda \times 10^{-6}$
Metglas 2605 SA1	$Fe_{78}B_{13}Si_9$	1.56	600	27
Metglas 2605 SC	$Fe_{81}B_{13.5}Si_{3.5}C_2$	1.61	300	30
Metglas 2605CO	$Fe_{66}Co_{18}B_{15}Si_1$	1.8	400	35
Metglas 2705 M	$Co_{69}Fe_4Ni_1Mo_2Si_{12}B_{12}$	0.77	800	<0.5
Metglas 2714 A	$Co_{66}Fe_4B_{14}Si_{15}Ni_1$	0.57	1000	<0.5
Matglas 2826 MB	$Fe_{40}Ni_{38}B_{18}Mo_4$	0.88	800	12
Vitrovac 6025	$Co_{66}Fe_4B_{12}Si_{16}Mo_2$	0.55	600	0.3
Vitrovac 6030	$Co_{70}(FeMo)_2Mn_5(SiB)$	0.8	300	0.3

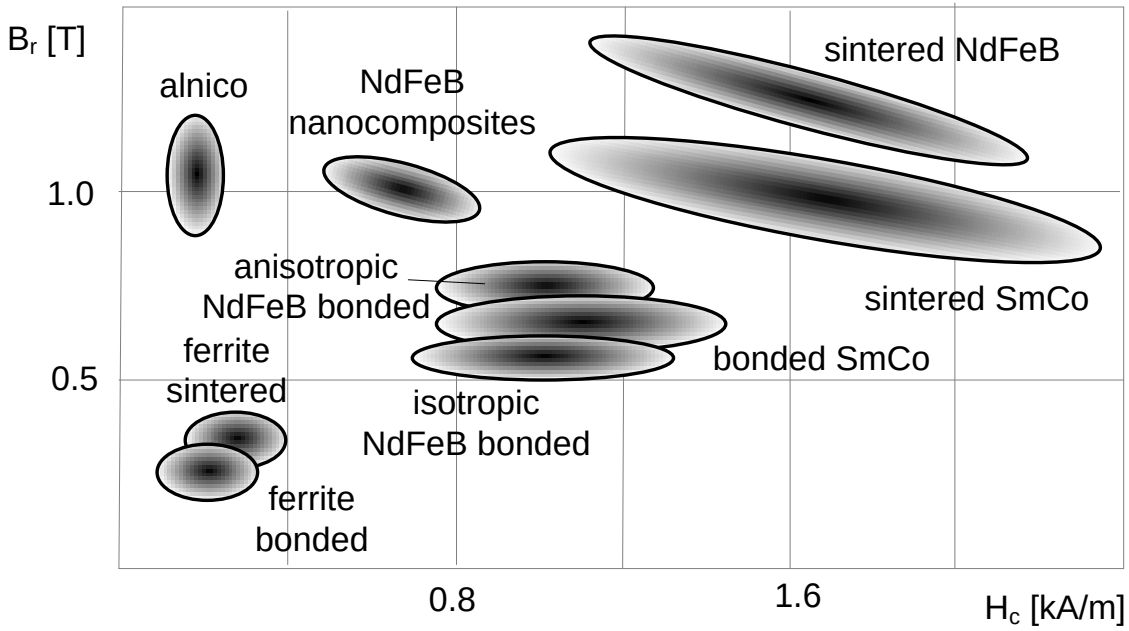



H_c [A/m]
1000
100
10
1
nanocrystalline
FeSi6.5
50NiFe
permalloy
grain size
1 nm
1μm
1 mm


μ
FINEMET Fe-Si-B-Nb-Cu
Amorph-Co
NANOPERM Fe-Zr-B-Cu
10^5
HITPERM FeCo-Zr-B-Cu
10^4
Amorph-Fe
SiFe
1.0
2.0
B [T]


compositional fluctuations
nucleation of bcc Fe-Si
initial stage of crystallization
optimum crystalline state
as quenched
amorphous Fe-Cu-Nb-Si-B
final
amorphous Nb&B enriched
bcc Fe-Si
Cu cluster


Ba-ferrite
Alnico 500
SmCO2
NdFeB
25 cm3
20 cm3
0.9 cm3
0.3 cm3
5 mm


Br [T]
1.0
0.5
alnico
NdFeB
nanocomposites
sintered NdFeB
anisotropic
NdFeB bonded
sintered SmCo
ferrite
sintered
bonded SmCo
isotropic
NdFeB bonded
ferrite
bonded
0.8
1.6
Hc [kA/m]