

MgB₂ wire and its application to electric power

<http://www.mrs.org/publications/epubs/proceedings/fall2001/e/>

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Power Device Req'mts

Application	T(K)	Field (T)	J _c (A/cm ²)
Fault-current controller	20-77	0.1 - 3	10 ⁴ - 10 ⁵
Large motor	20-77	4 - 5	10 ⁵
Generator	20-50	4 - 5	10 ⁵
SMES	20-77	5 - 10	10 ⁵
Power cable	65-77	< 0.2	10 ⁴ - 10 ⁵
Transformer	25-77	0.5 - 2	8×10 ⁴

*R. D. Blaugher, et al., THERMEC*2000*



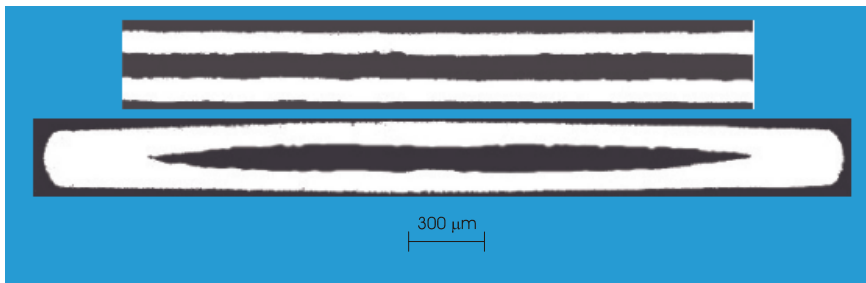
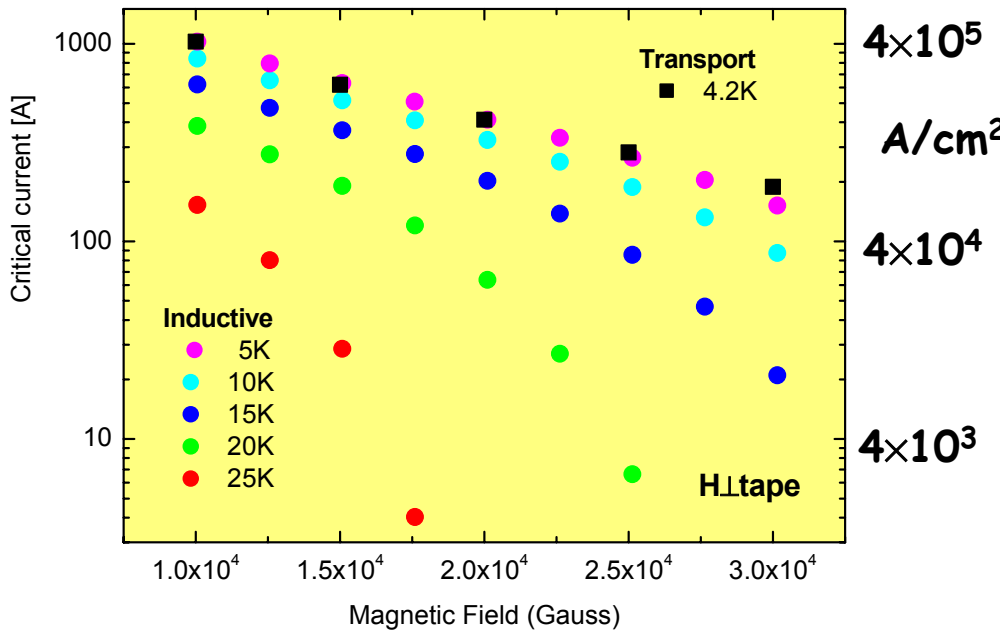
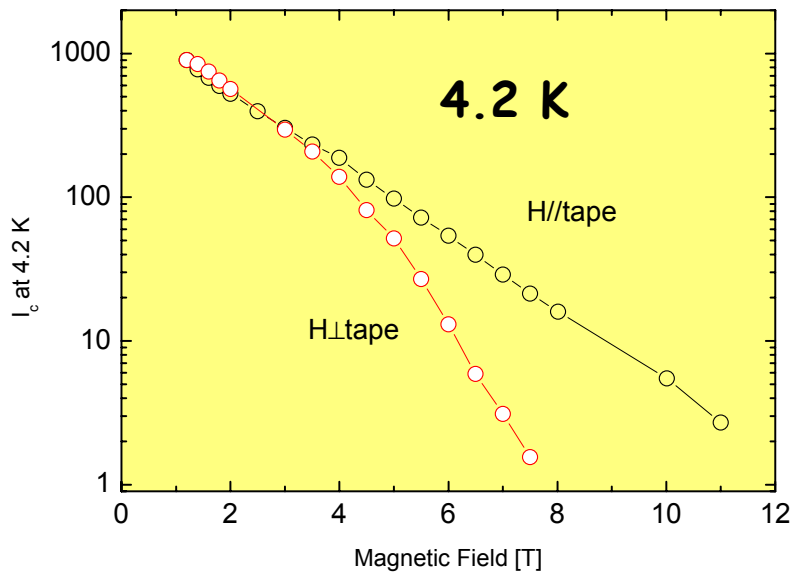
Madison, 18 July 2001

J_c @ 1 T (A/cm²)

<u>Group</u>	<u>4.2 K</u>	<u>25 K</u>
Geneva	250,000	100,000
Wollengong		59,000
Karlsruhe	100,000	37,000
Grasso (10 m!)	100,000	50,000
Ames	500,000!	(200,000?)

INFM-Genova

Ni-Sheathed MgB₂ Tape

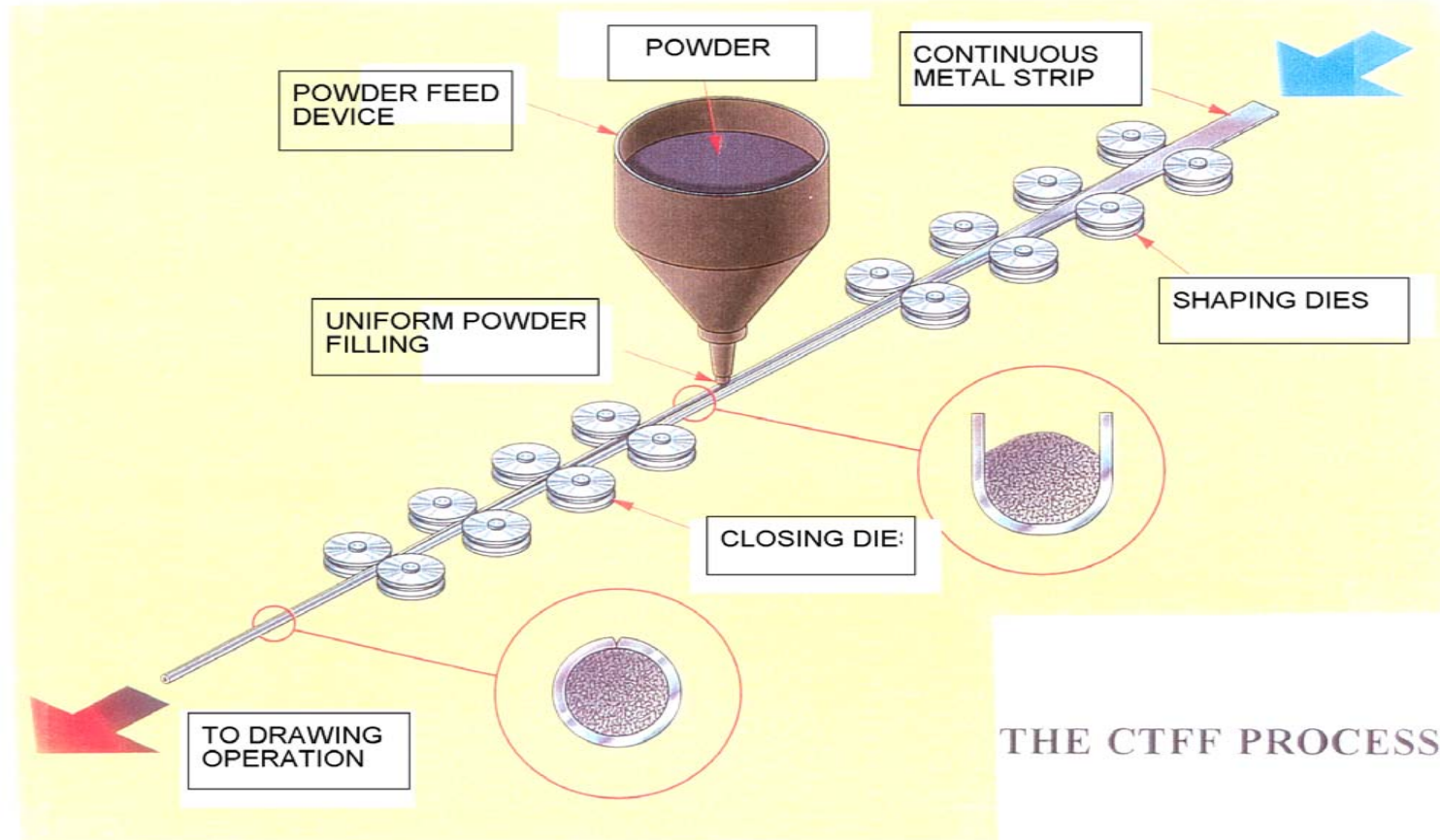


Ex-Situ Sintered
 Tape dimensions: 3.5 mm x 0.35 mm
 Filling factor 20% $A_{sc} = 2.5 \times 10^{-3} \text{ cm}^2$
 Treated at 900°C for 2 hours in Ar

INFM-Genova, G. Grasso, A. Malagoli, V. Braccini, S. Roncallo, and A.S. Siri, Italy

HyperTech CTFE for MgB₂

CONTINUOUS TUBE FORMING AND FILLING (CTFF)



HyperTech

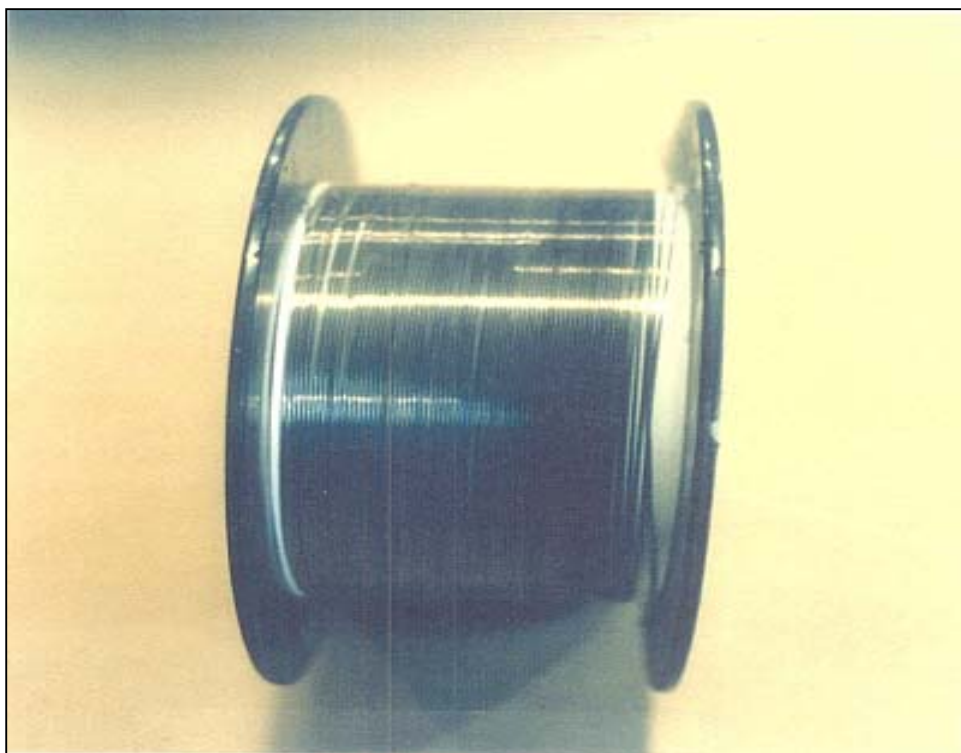
Representative J_c's

Temperature, K	4K	4K	4K
Field, T	0-0.2	1	3
J _c -kA/mm ²	7.5*	3*	0.2
A/cm²	750,000	300,000	20,000
Temperature, K	30K	30K	
Field, T	0-0.2	1	
J _c -kA/mm ²	0.32	0.1	
	(over 300 amps)	(over 100 amps)	
A/cm²	32,000	10,000	

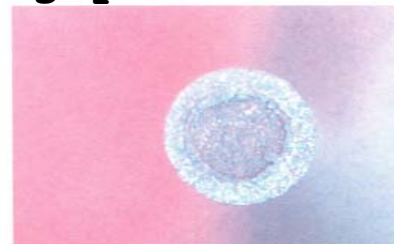
* by extrapolation due to flux jump and lack of stabilization

HyperTech MgB₂ Wire

60 meters, 1.2 mm Mono



MgB₂ CTFE Iron in Monel



Multi-filament





Wire

Cost Issues

Merit Factor for Superconducting Wire:
 $C/P = \$/\text{kAmp} \times \text{meters}$

<u>Wire</u>	<u>C/P</u>	<u>Cost Driver</u>
NbTi (4.2 K, 2 T)	0.90	Materials (Nb)
Nb ₃ Sn (4.2 K, 10 T)	10	Materials (Nb)
Bi-2223 (25 K, 1 T)	20	Materials (Ag)
Y-123 (25 K, 1 T)	4	Capital Plant



MgB₂ Wire C/P

Assumptions/Givens:

- $J_c = 100,000 \text{ A/cm}^2$
- $I_c = 2000 \text{ A/wire (Area} = 2 \text{ mm}^2)$
- Non-Materials C/P = 0.11 \$/kA·m (NbTi)

Alfa Aesar MgB₂ Price Quote (10 kg)

- 750 \$/kg (0.75 \$/gm)

MgB₂ Wire C/P

- 2.03 \$/kA·m @ 25 K, 1 T



The American Physical Society

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U14 DMP: MgB₂ Focus Session

MgB₂ Opportunities

20 - 30 K, 0 - 3 T

- Transformers
- Rotating Machinery
- Cables (?)



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Transformer

Cost of Ownership

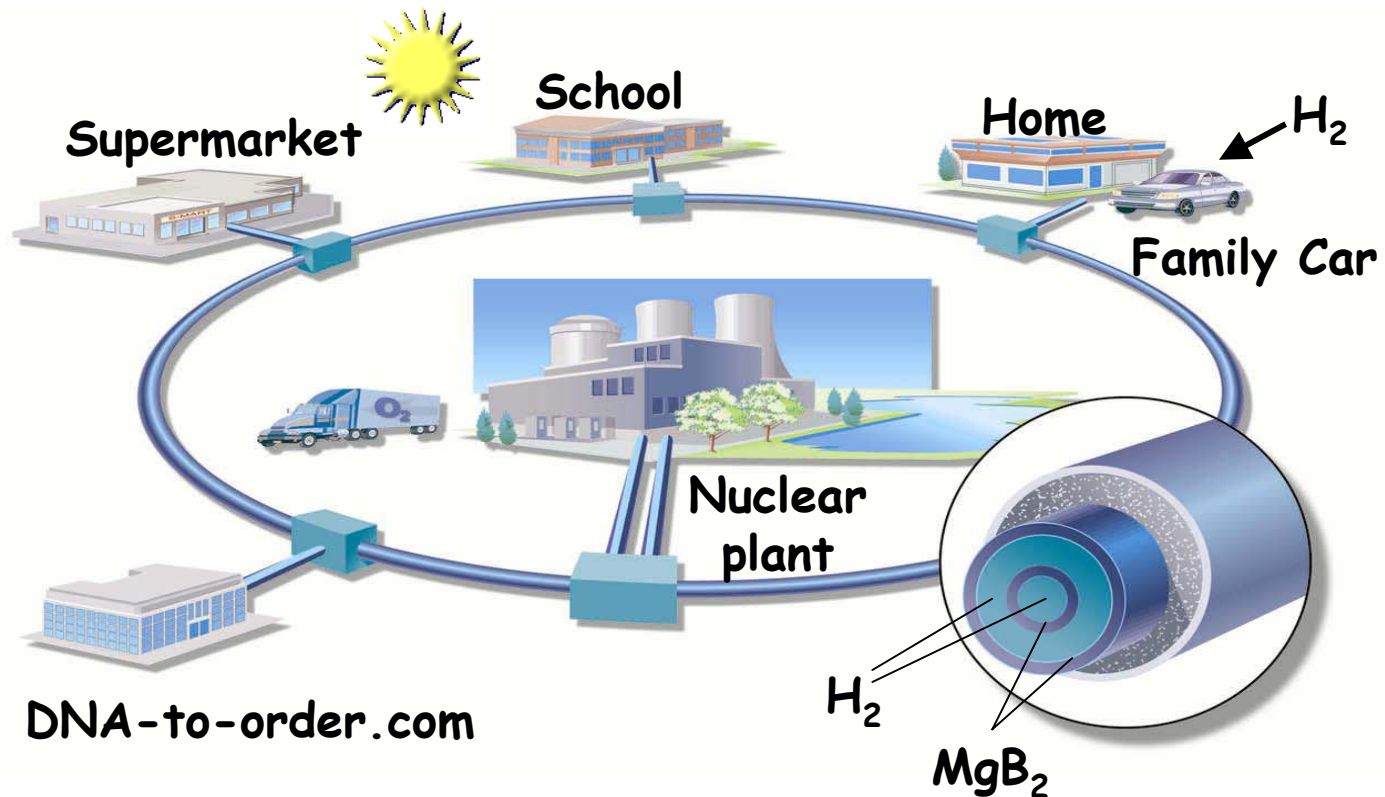
Item	Units	Cu	BSCCO	BSCCO	YBCO CC	MgB ₂
Operating Temperature	K	300	77	77	68	25
Operating Field	T	2	0	2	2	2
Electrical Losses	W/kA×m	60	0.25	0.25	0.25	0.125
"Effective" Carnot Factor	W_i/W_e	1	20	20	23.6	76
Cryo-unit Electrical Load	W/kA×m	0	5	5	5.9	9.5
Total Cost of Losses @ 1 \$/W	\$/kA×m	60	25	25	29.5	47.5
Cryo-unit Cost @ 5 \$/W Rating	\$/kA×m	0	25	25	29.5	47.5
Wire Cost (T, H)	\$/kA×m	5	50	150	50	2
Total Cost of Ownership	\$/kA×m	65	80	180	85	59



Critical Wire Issues

<u>20 - 30 K</u> <u>1 - 3 T</u>	J _c , H _{irr}	Length
BSCCO/OPIT	++++	++++
YBCO CC	+++++++	
MgB ₂	+++ ac Losses ?	+++++++

"SuperCity"



P.M. Grant, The Industrial Physicist, Feb/March Issue, 2002

<http://www.aip.org/tip/INPHFA/vol-8/iss-1/p22.pdf>



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Where there is no vision,
the people perish...

Proverbs 29:18

EPRI

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