The high gas pressure HIP influence on structure and transport properties of MgB2 superconductors of single and multicore composition

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ICMC Conference

Wroclaw

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Plan of presentation

Preparation of Wires

- PIT
- HIP

SEM results

- powder density
- grain sizes
- barrier quality

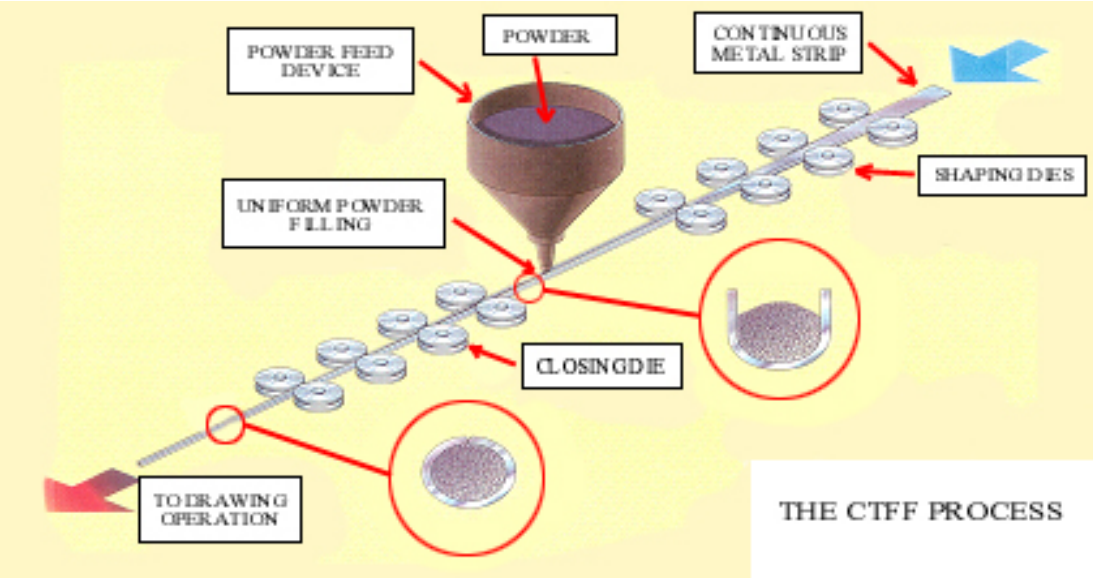
Critical current

- improvement example
- Fp shift

Summary

PIT (Powder In Tube) wires prepared by Hyper Tech, USA

CTFF – continuous tube forming and filling



Composition of wires

Table 1 Structure and chemical composition of wires annealed through HIP

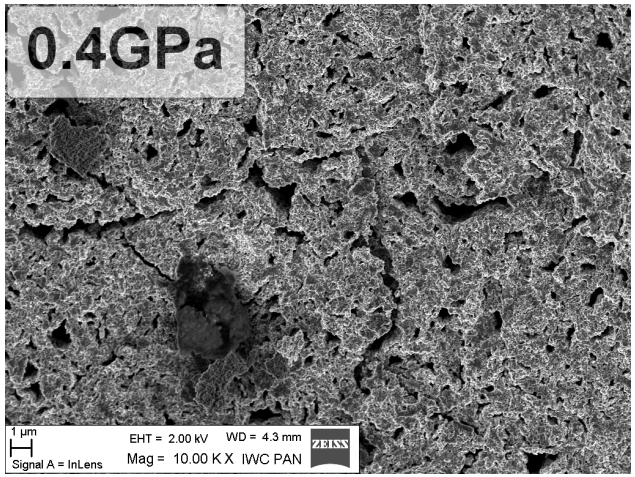
wire ID	no. of cores	barrier	core sheath	outer sheath	B source	Mg to B ratio	additive	d [mm]	fill factor [%]
03	6	Nb	Cu	Monel	SMI	1:2	C	0.83	17.7
18	6	Nb	Cu	Cu	99B	1.10:2	SiC	0.83	14.9
22	18	Fe	Cu	Glidcop	Ts	1:2	C4H6O3	0.83	13.9
30	6	Nb	Cu	Monel	99B	1.10:2	SiC	0.83	15.0
43	18	Nb	Cu	Monel	99B	1.10:2	-	0.83	15.0
70	1	Fe	Cu	-	Ts	1:2	C4H6O3	0.83	28.7
76	6	Nb	Cu	Glidcop	99B	1.10:2	SiC	0.83	16.6
92	6	Nb	Cu	Cu	99B	1.10:2	-	0.83	19.4

Wires were HIP-ed (Hot Isostatic Pressure) in Argon atmosphere.

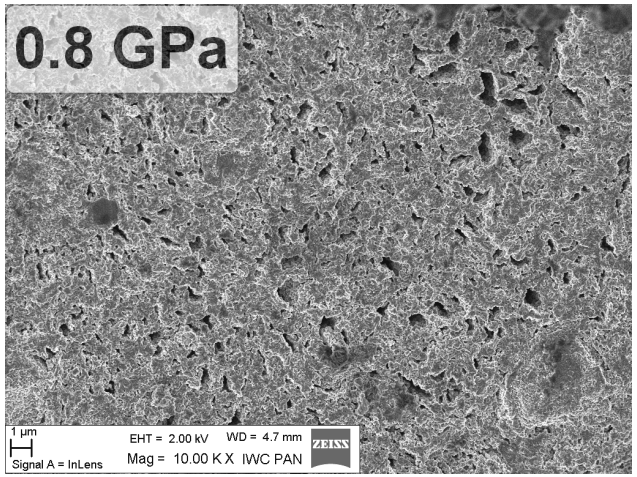
HIP parameters

process ID	temperature [^{o}C]	pressure [kbar]	time [h:min]
I	700	0.001	0:15
II	700	0.01	0:15
III	700	0.2	1:00
IV	700	4	0:30
V	600	8	12:00
VI	700	10	0:15
VII	700	14	0:30

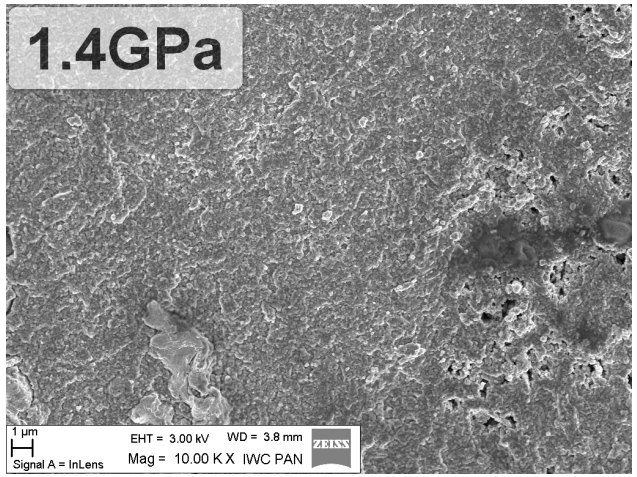
Sample 43 annealed under 3 different pressures



0.4GPa / 700 / 30min



0.8GPa / 600 / 12h

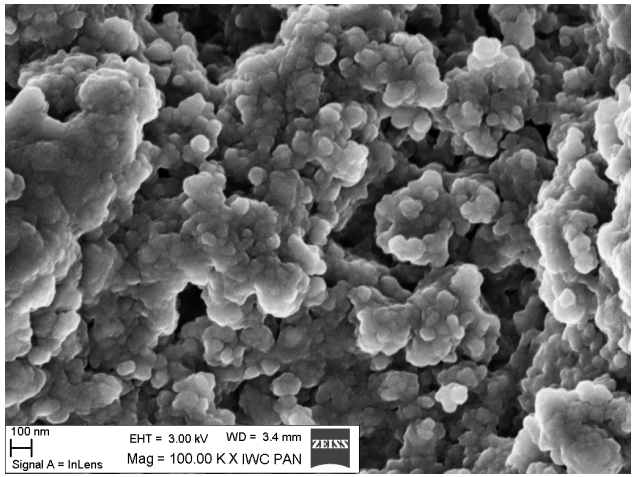


1.4GPa / 700 / 30min

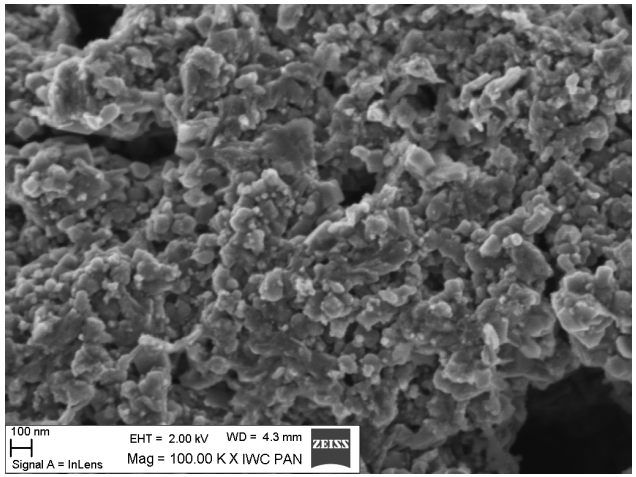
Significant improvemet!

Number of visible gaps in superconducting core is reduced with higher pressure of HIP

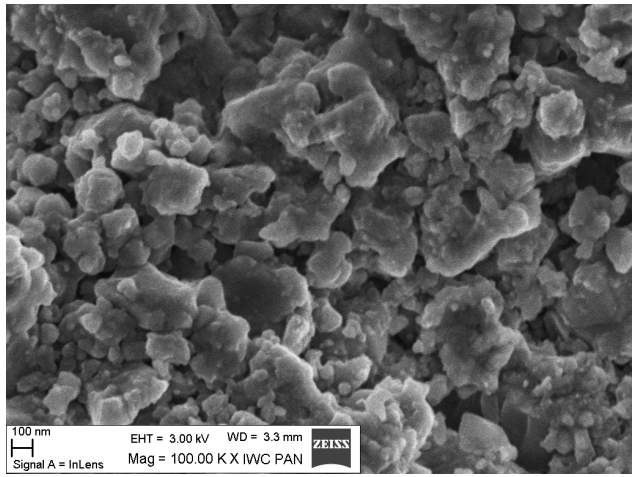
Sample 22 annealed under 3 different pressures



1bar / 700 / 15min



0.8GPa / 600 / 12h



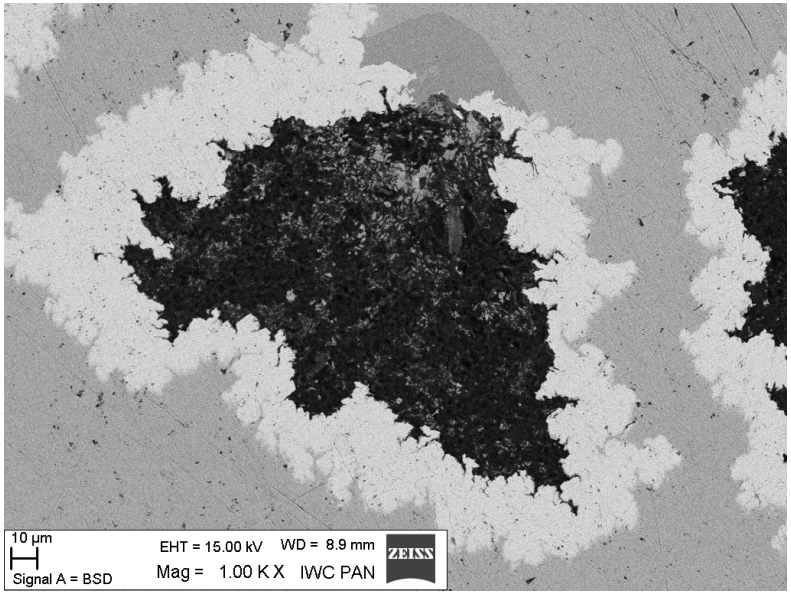
1.4GPa / 700 / 30min

No visible effect

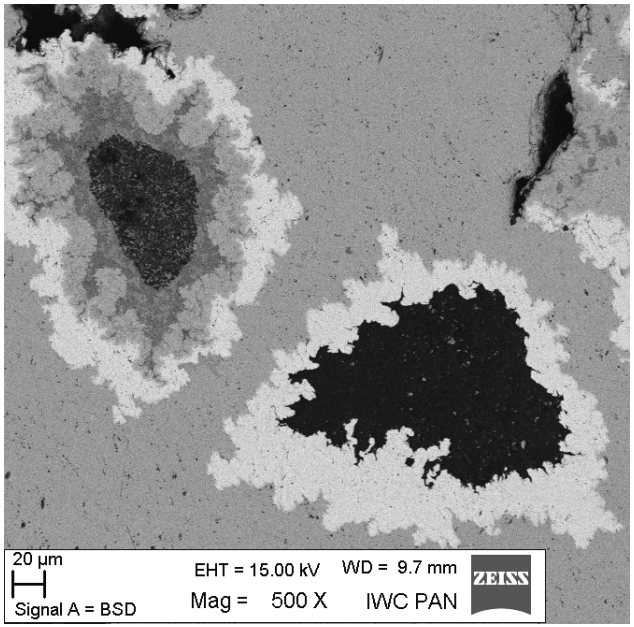
Grain sizes for 1bar and 1.4GPa are similar.

There is a difference for 0.8GPa, but related to lower temperature.

Sample 18 annealed under 2 different pressures



1bar / 700 / 15min



1.4GPa / 700 / 30min

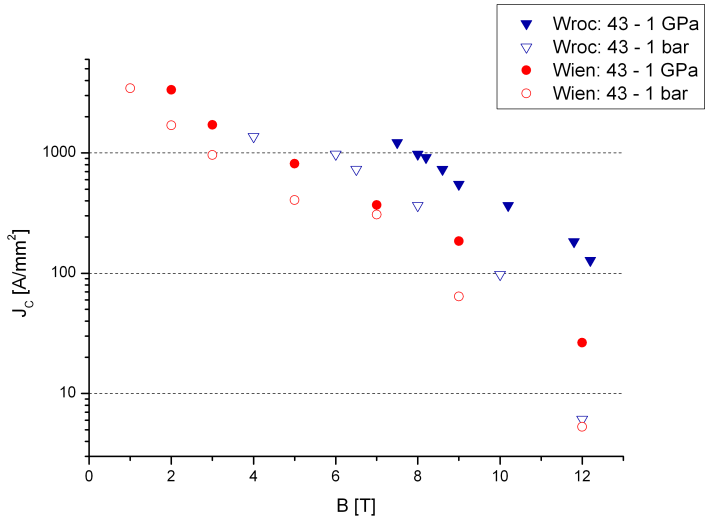
Barrier defects significant under high pressure

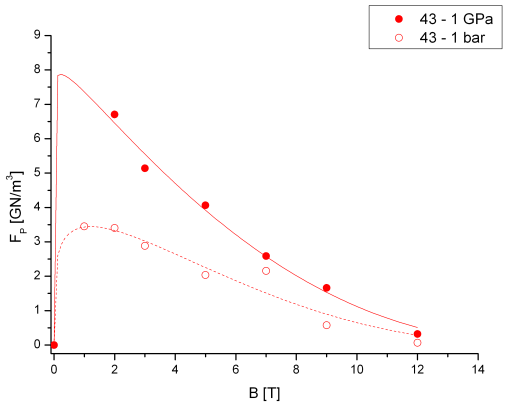
Minor defect under 1bar results in a local reaction

Any defect under high pressure causes destruction of the whole core

Sample 43 annealed under 2 different pressures

Measurements done independently in Wroclaw and Wien on different wire samples.





Improvement

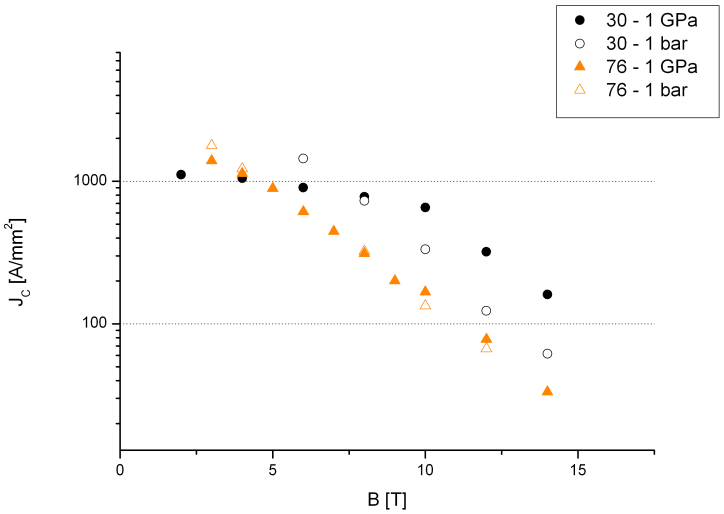
Both measurements show increase in j_C for HIP at 1GPa

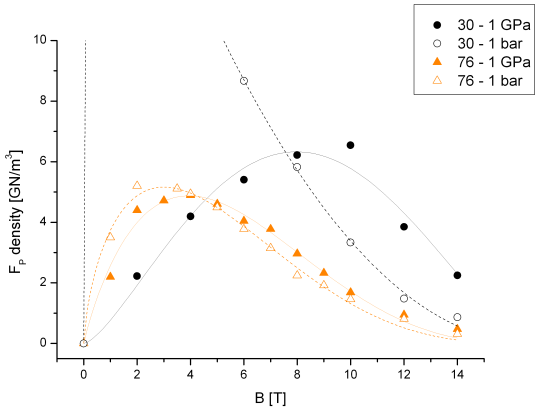
(difference in j_C between Wroclaw and Wien may be caused defect in Wien samples, different joints, distance beetwen probes etc.)

Pinning force significantly increased after HIP at 1GPa.

Samples 30 and 76 annealed under 2 different pressures

Both samples have SiC addition.





For both wires HIP at 1GPa caused increse in j_C and F_P at high B, but a decrease at lower B. Observed shift towards higher B at F_P plot indicates formation on intra-grain pinning centers.

Summary

- Superconducting MgB_2 wires of various sheath/barrier material and additives were annealed at various conditions
- High pressure proved to increase density of superconducting core
- Significance of barrier quality at higher pressure was shown with SEM pictures
- HIP improved critical current density and pinning force for many of used wires (not all)
- With SiC addition HIP improved wire parameters at high magnetic field

Thank you!

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