Nature, 1 March 2001

How did we ever miss it!

Superconductivity at 39 K in magnesium diboride

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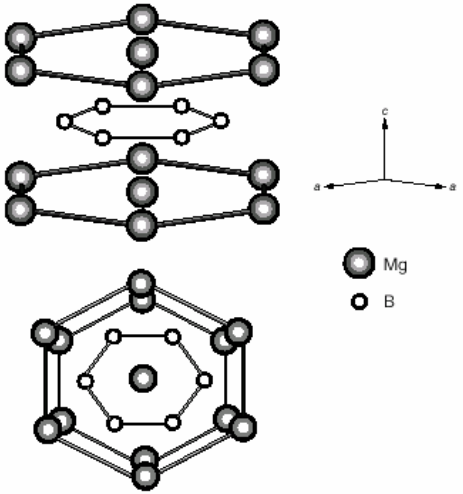


Figure 2 Crystal structure of MgB_2.

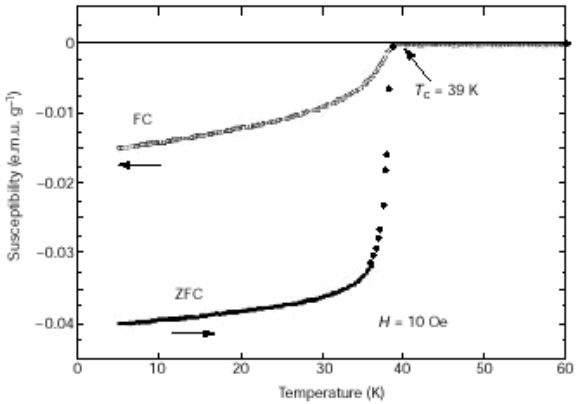


Figure 3 Magnetic susceptibility χ of MgB_2 as a function of temperature. Data are shown for measurements under conditions of zero field cooling (ZFC) and field cooling (FC) at 10 Oe.

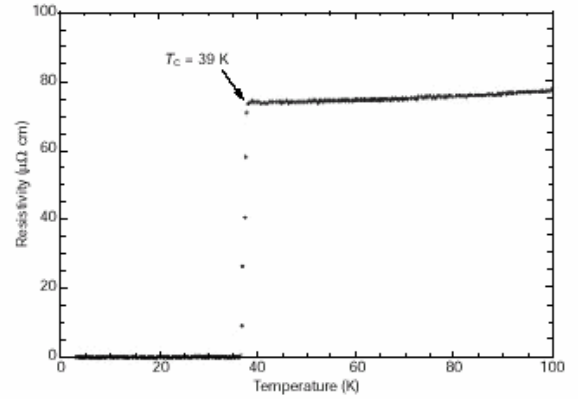
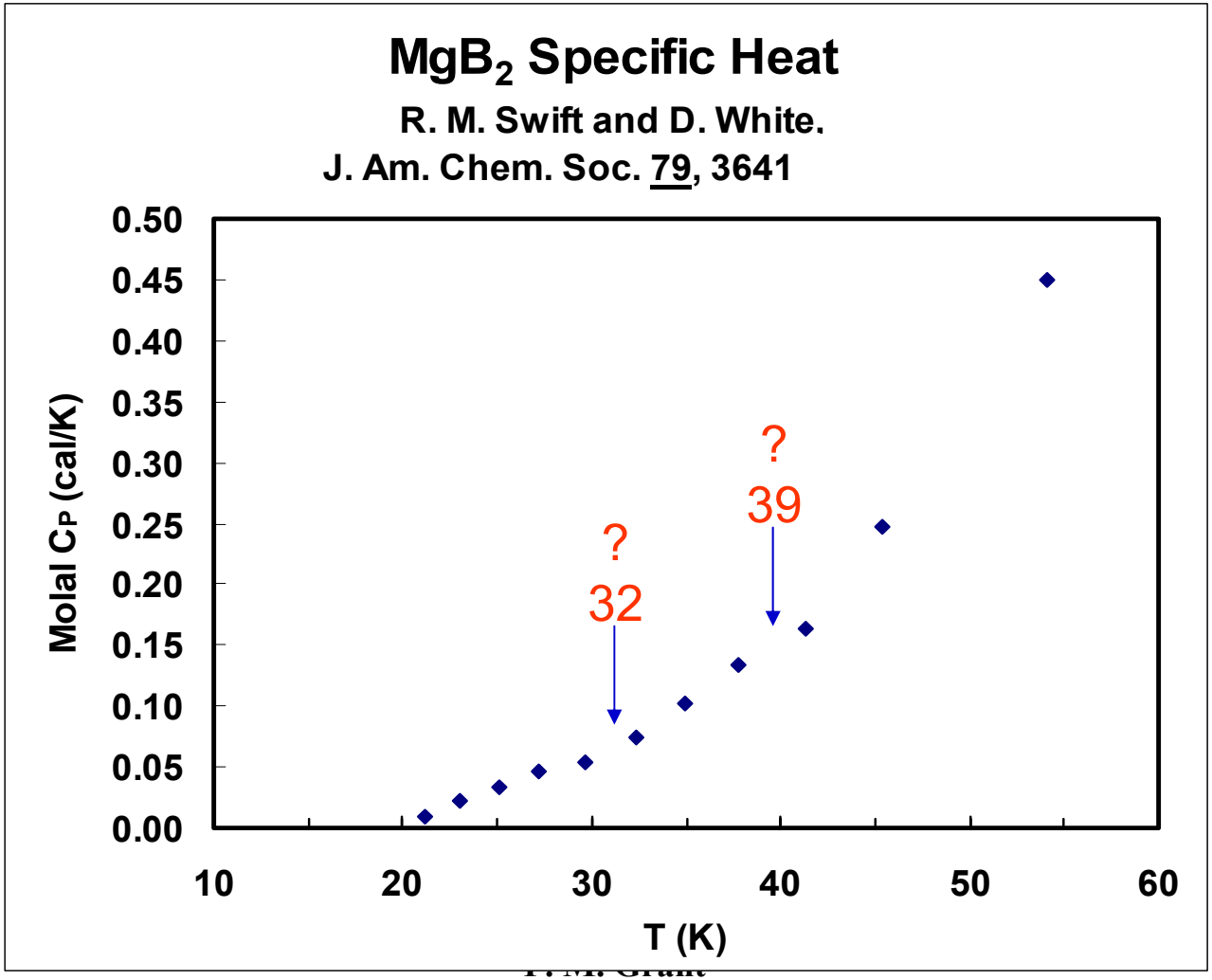


Figure 4 Temperature dependence of the resistivity of MgB_2 under zero magnetic field.

Maybe We Didn't!



Physics of MgB_2

- Strong B isotope effect
- Distinct Mg-B optical phonon branch
- Tunneling suggests s-wave gap
- Semimetallic Band Structure
- T_c predicted by McMillan/Eliashberg strong e-p coupling theory
- Is MgB_2 a low or high T_c superconductor?

Write your answer here _____

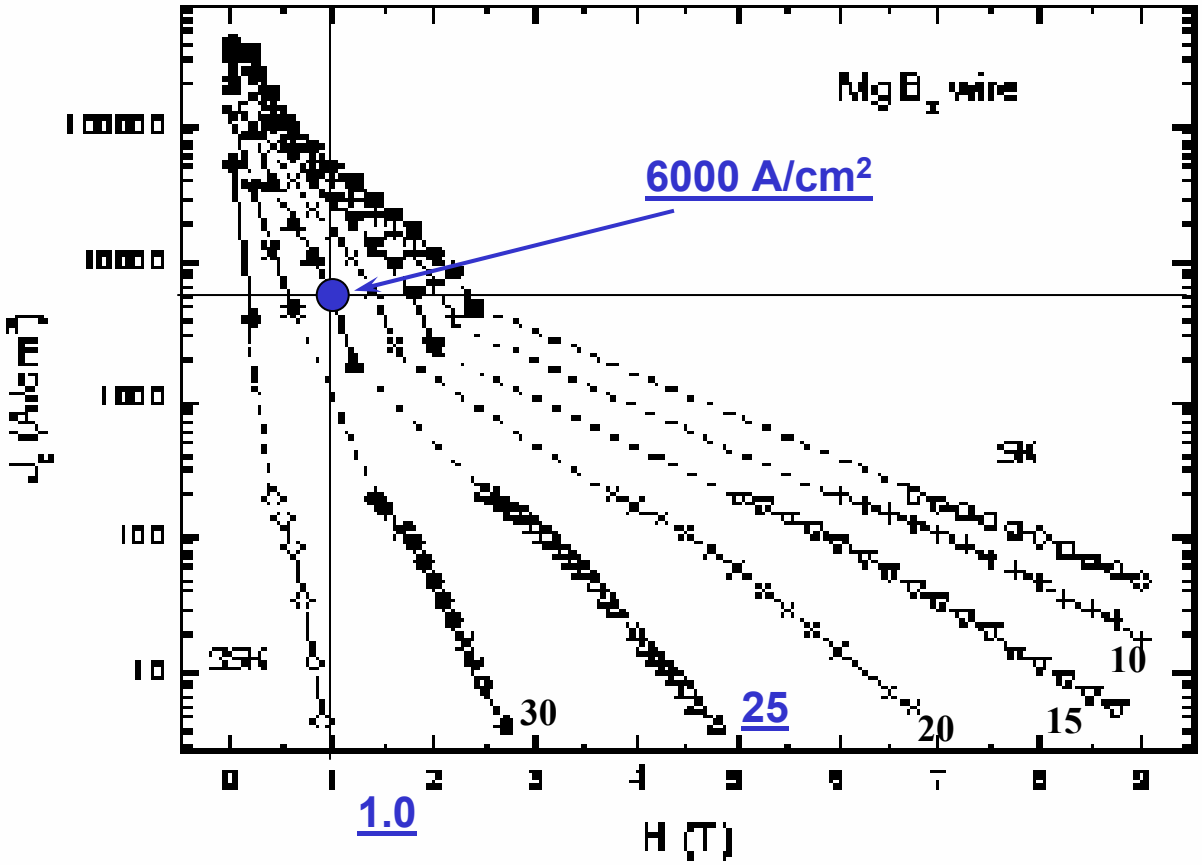
Physics story is pretty much over

MgB_2 Wire: J_c vs H

Early Results

Sleepless in Seattle

Mg-infused Boron fiber "wire"



Ames Group
ArXiv:cond-mat/0102289
V2 17 Feb 2001

Unlike the HTSC copper oxides, there is little evidence of weak link behavior!

Nature, 31 May 2001

Getting Better!

Superconductivity

Rehearsals for prime time

Paul Grant

Superconductivity seems to have been forever waiting in the wings. Although superconducting power cables are about to go live, will the newest material, magnesium diboride, become the class act of the future?

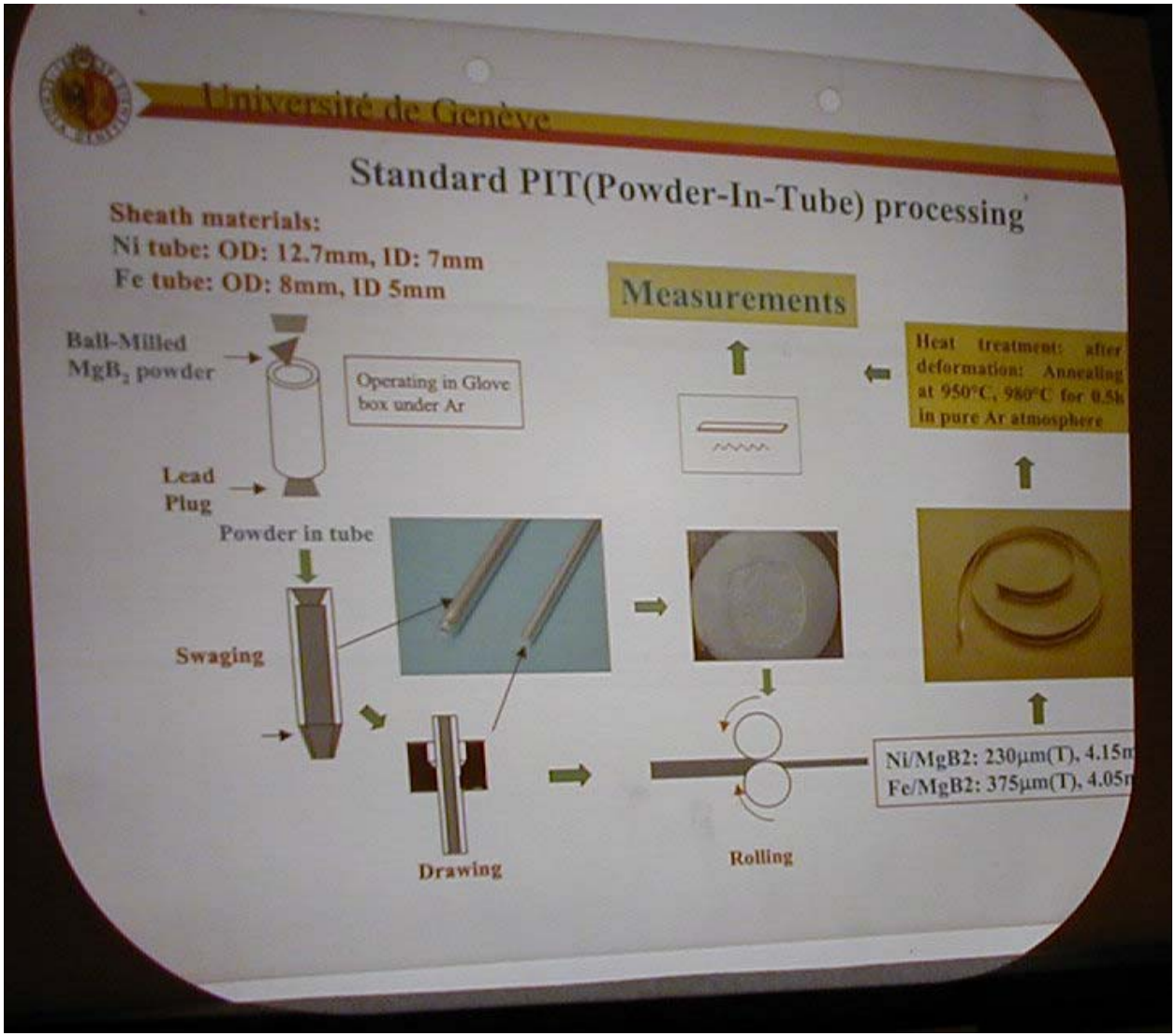
High critical currents in iron-clad superconducting MgB_2 wires

S. Jin, H. Mavoori, C. Bower & R. B. van Dover

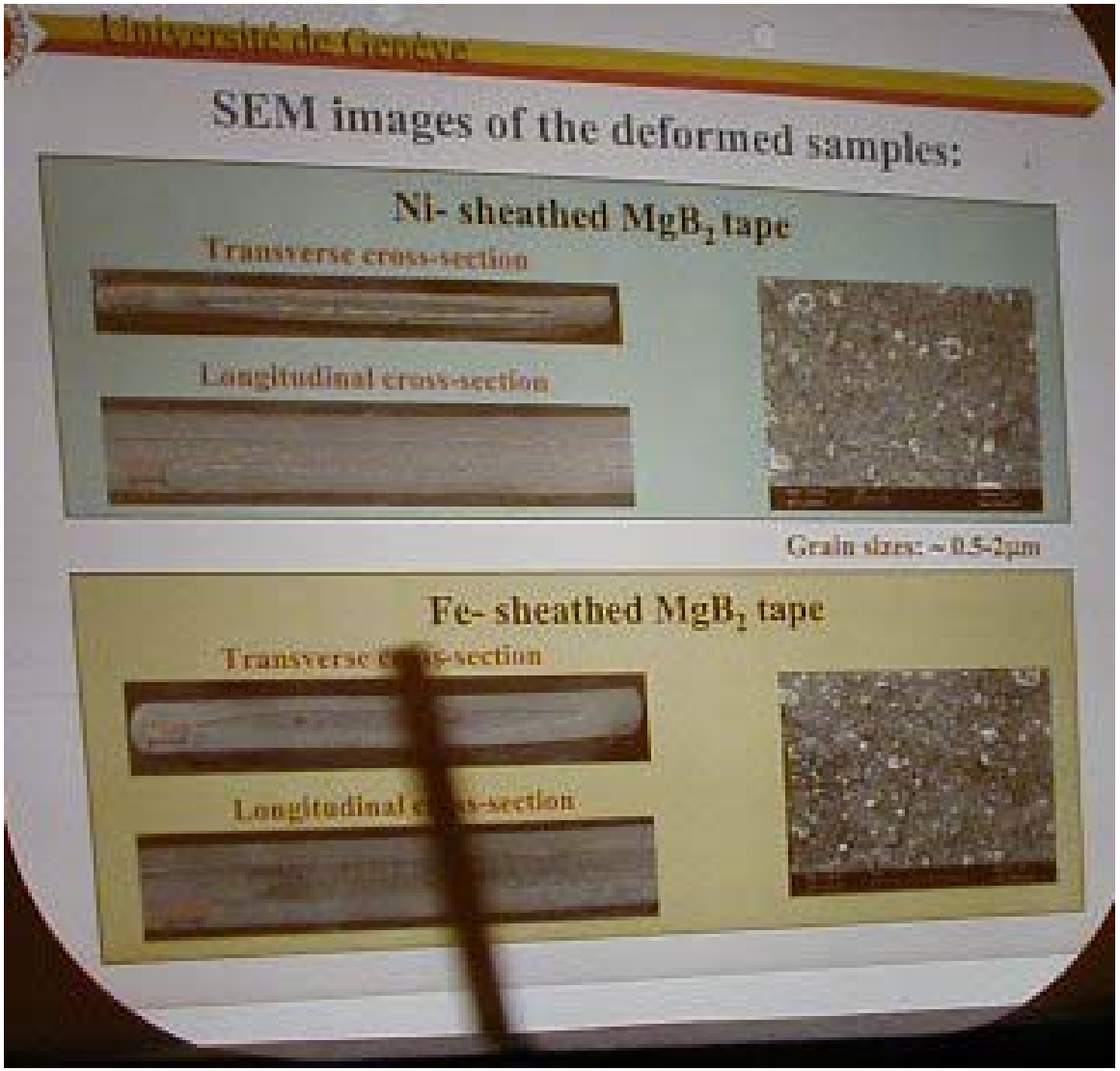
Agere Systems/Lucent Technologies, Murray Hill, New Jersey 07974, USA

	4.2 K	25 K
J_c @ 1 T (A/cm^2)	150,000	35,000

Geneva 1


Université de Genève
Standard PIT(Powder-In-Tube) processing
Sheath materials:
Ni tube: OD: 12.7mm, ID: 7mm
Fe tube: OD: 8mm, ID 5mm
Measurements
Ball-Milled
MgB2 powder
Operating in Glove box under Ar
Heat treatment: after deformation: Annealing at 950°C, 980°C for 0.5h in pure Ar atmosphere
Lead Plug
Powder in tube
Swaging
Drawing
Rolling
Ni/MgB2: 230μm(T), 4.15m
Fe/MgB2: 375μm(T), 4.05m

Geneva 2


Université de Genève
SEM images of the deformed samples:
Ni- sheathed MgB_2 tape
Transverse cross-section
Longitudinal cross-section
Grain size: ~ 0.5-2μm
Fe- sheathed MgB_2 tape

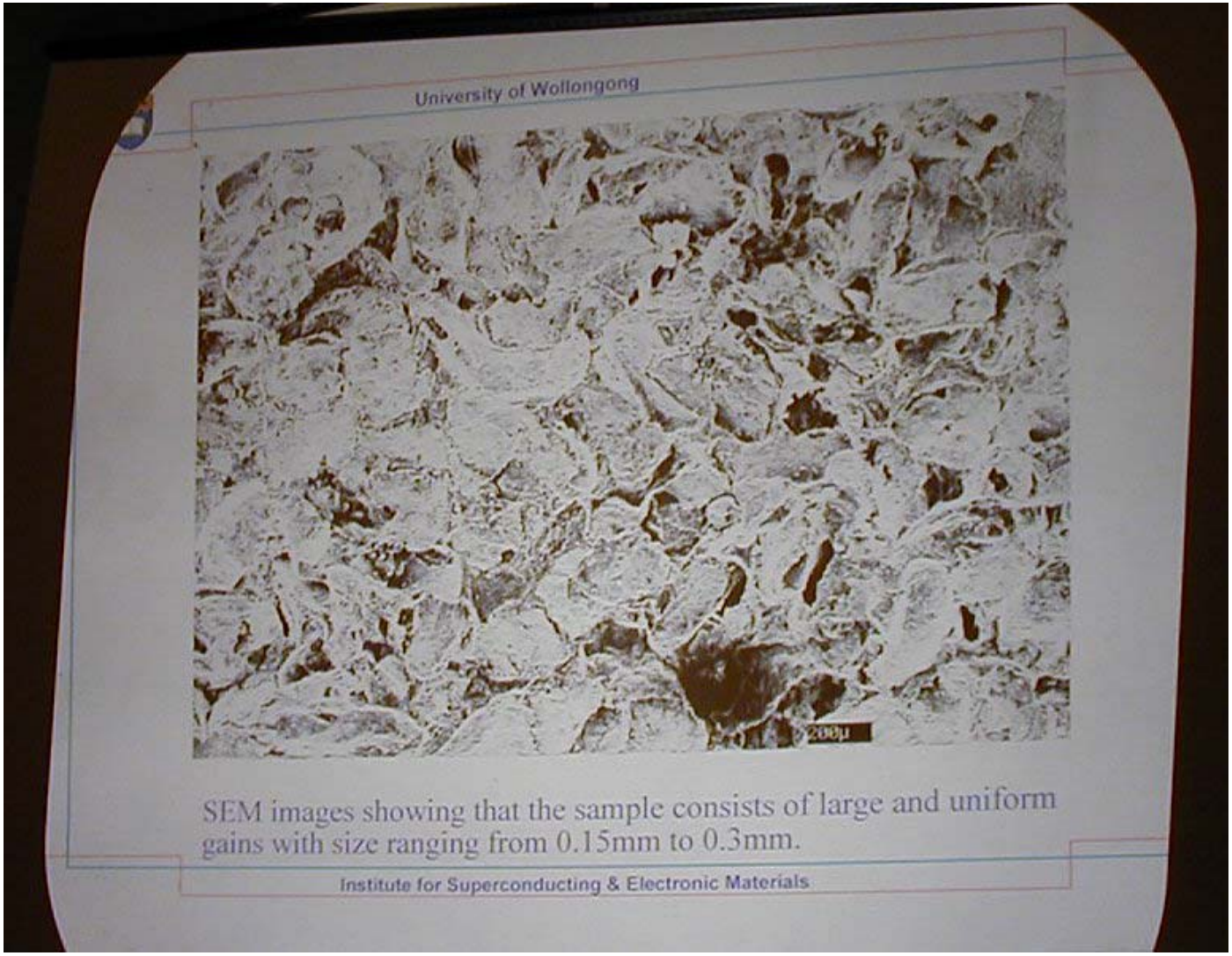
Madison, 18 July 2001

Getting Really Good!

J_c @ 1 T (A/cm^2)

Group	4.2 K	25 K
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?)

Wollengong 5



Cost Issues: MgB2 Alfa Aesar

Assumptions/Givens:

- J_C = 100,000 A/cm^2
- I_C = 2000 A/wire (Area = 2 mm^2)
- Non-Materials C/P = 0.11 $/kA·m (NbTi)

Alfa Aesar MgB_2 Price Quote (10 kg)

- 750 $/kg (0.75 $/gm)

MgB_2 Wire C/P

- 2.03 $/kA·m @ 25 K, 1 T

MgB_2 Wire: Cost Issues "Commodity-Based"

- Assumptions
  - J_C = 100,000 A/cm^2 (25 K, 1 T)
  - I_C = 2000 A/wire (Area = 2 mm^2)
  - Non-MgB_2 Materials C/P = 0.11 $/kA-m (from NbTi addenda)
  - Mg Spot = 0.003 $/gm (e.g., Ag = 0.14 $/gm)
  - Boron Spot = 0.004 $/gm (as borax ore)
  - Boron Extraction = 0.01 $/gm
  - MgB_2 Reaction = 0.01 $/gm (sinter & heat treat)
- MgB_2 Wire C/P
  - **0.16 $/kA-m @ 25 K, 1 T !!!**

MgB_2 wire almost too cheap to "kiloAmp" meter!