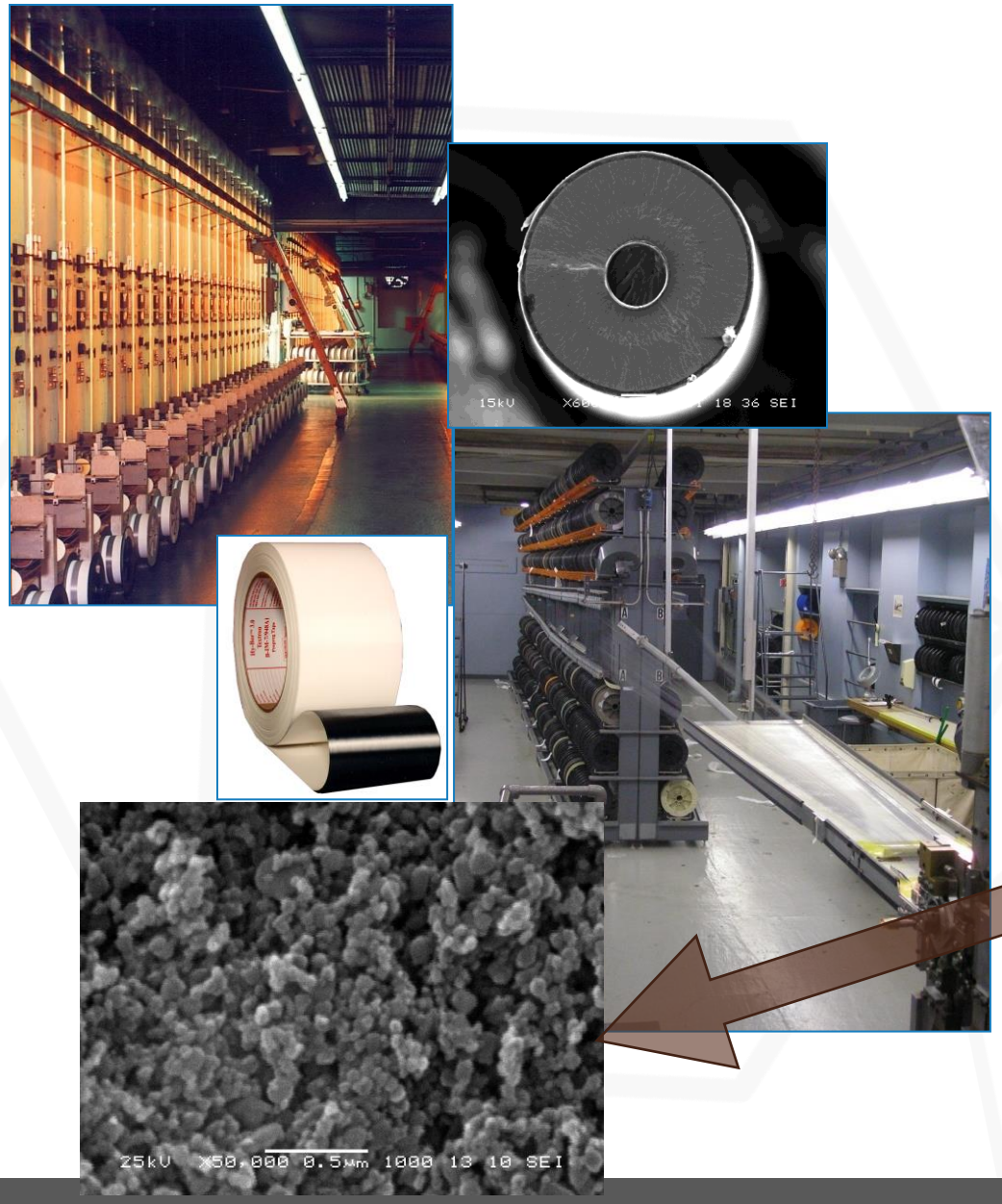
Boron nanopowder for MgB_2 superconductors

Specialty Materials, Inc.
1449 Middlesex Street
Lowell, Massachusetts 01851

SMI's Products



- **Boron**
  - CVD fiber (100 µm and 140 µm)
  - Boron fiber-reinforced composites for aerospace (F-15, helicopters, satellites)
  - Boron-carbon hybrid composites (Hy-Bor®) for aerospace (unmanned Predator) and sporting goods
  - **Boron powder (R&D) for superconducting wire**
- **Silicon Carbide**
  - CVD fiber (140 µm) for solar energy and aerospace industries

Specialty Materials' boron nanopowder for MgB_2 superconductors

- SMI starts with nano-sized boron powder produced by RF plasma synthesis
- The boron nanopowder is reacted to make magnesium diboride (MgB_2) superconducting wire

Advantages of plasma synthesized boron powder

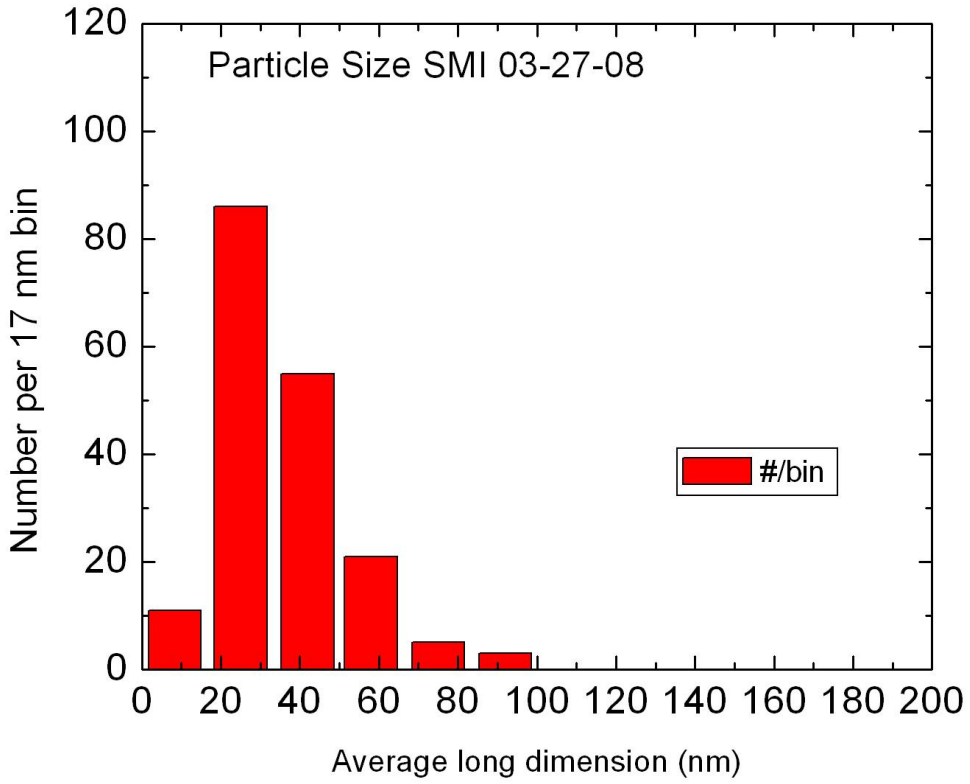
- Controlled purity nano-sized boron powder
- Dopants added in the gas phase
  - Precise control over composition
  - Finely dispersed
  - Homogeneous doping

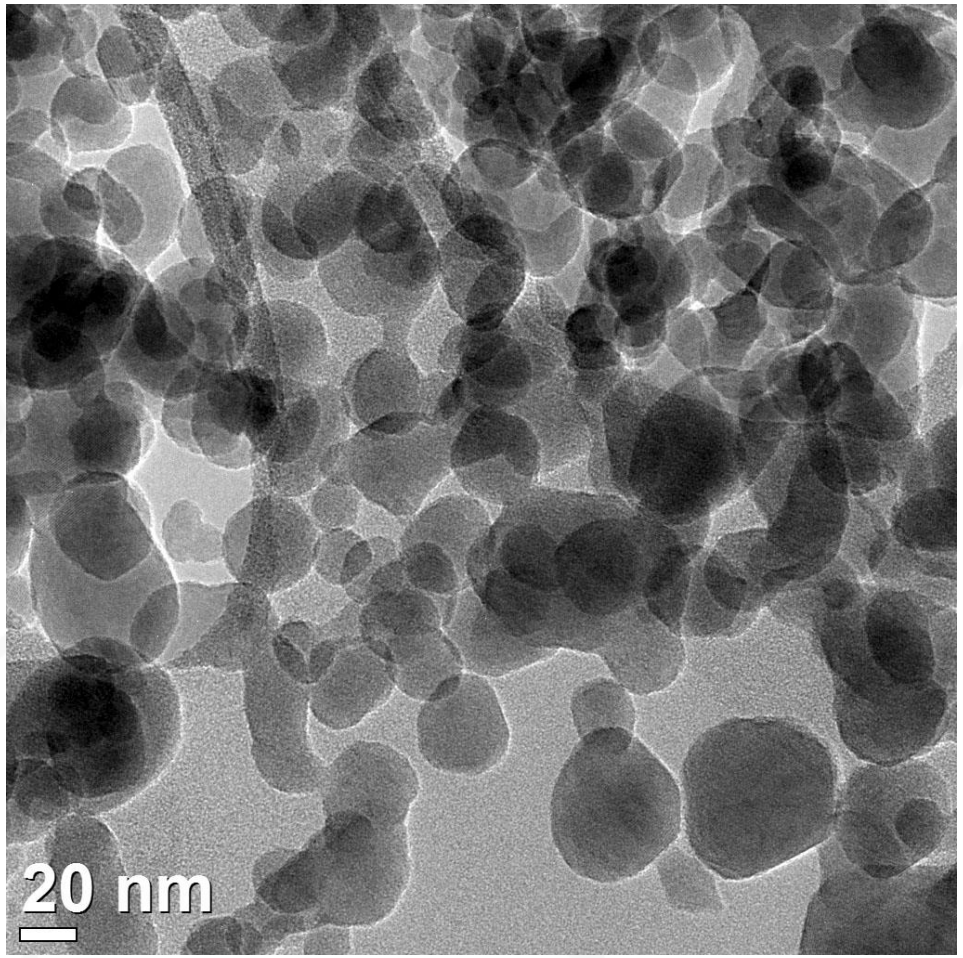
SMI’s pilot plasma synthesis system

RF plasma system

Plasma torch

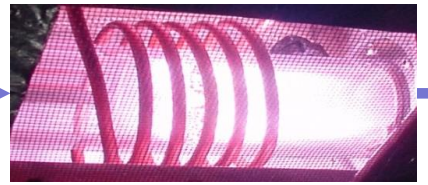
Boron nanopowder



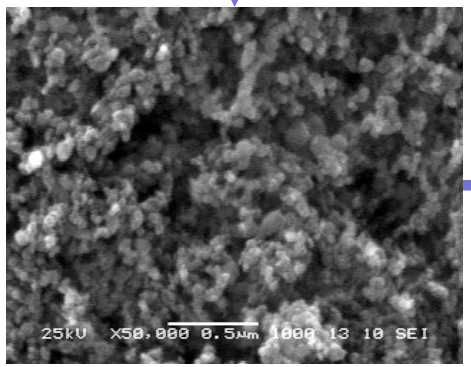


Boron nanopowder to MgB_2 wires

$BCl_3 + H_2 +$ dopant(s)

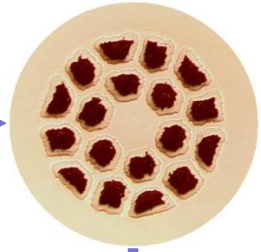


Plasma torch



Doped boron powder

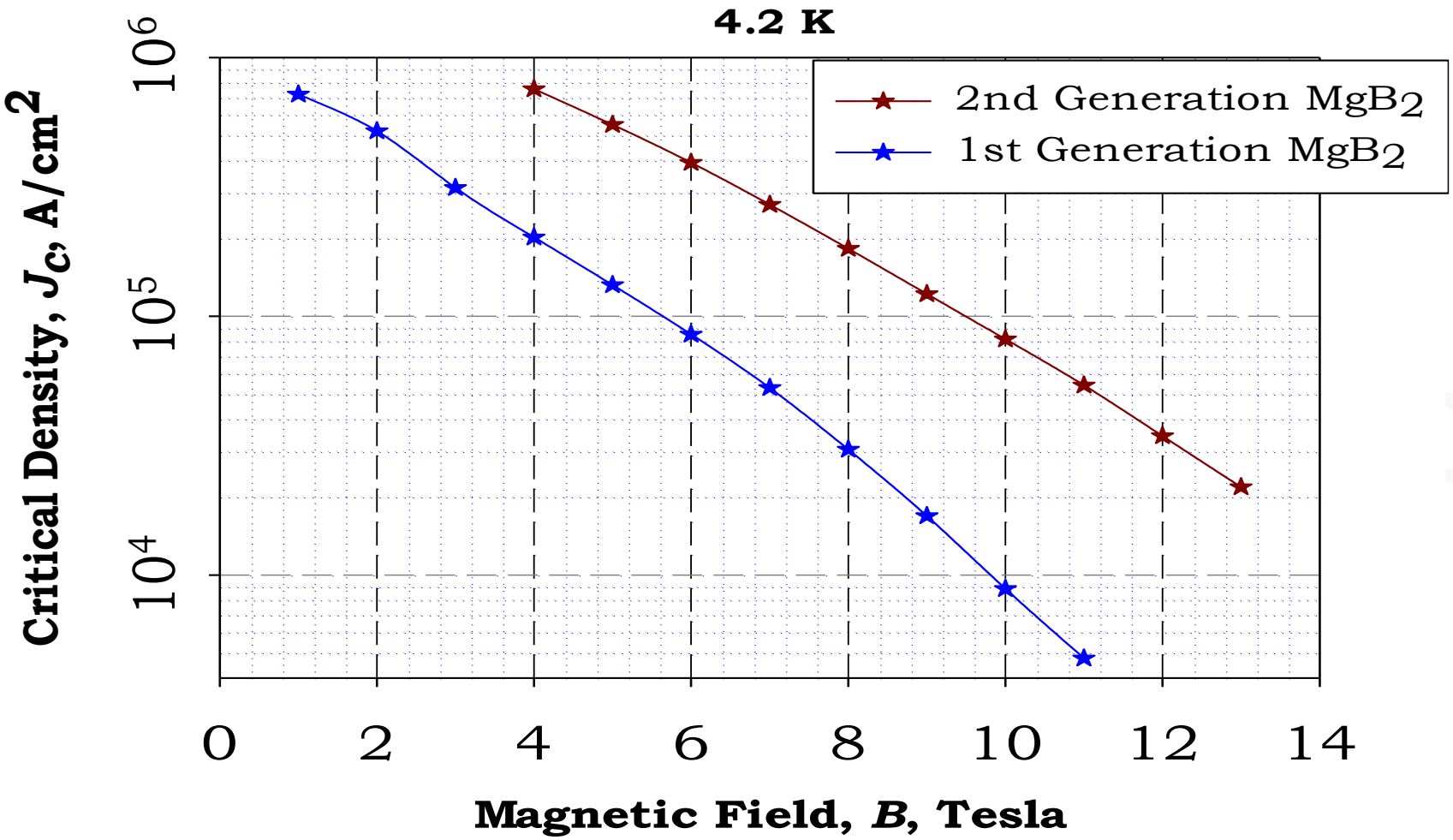
Mg Powder



MgB_2 powder-in-tube wire

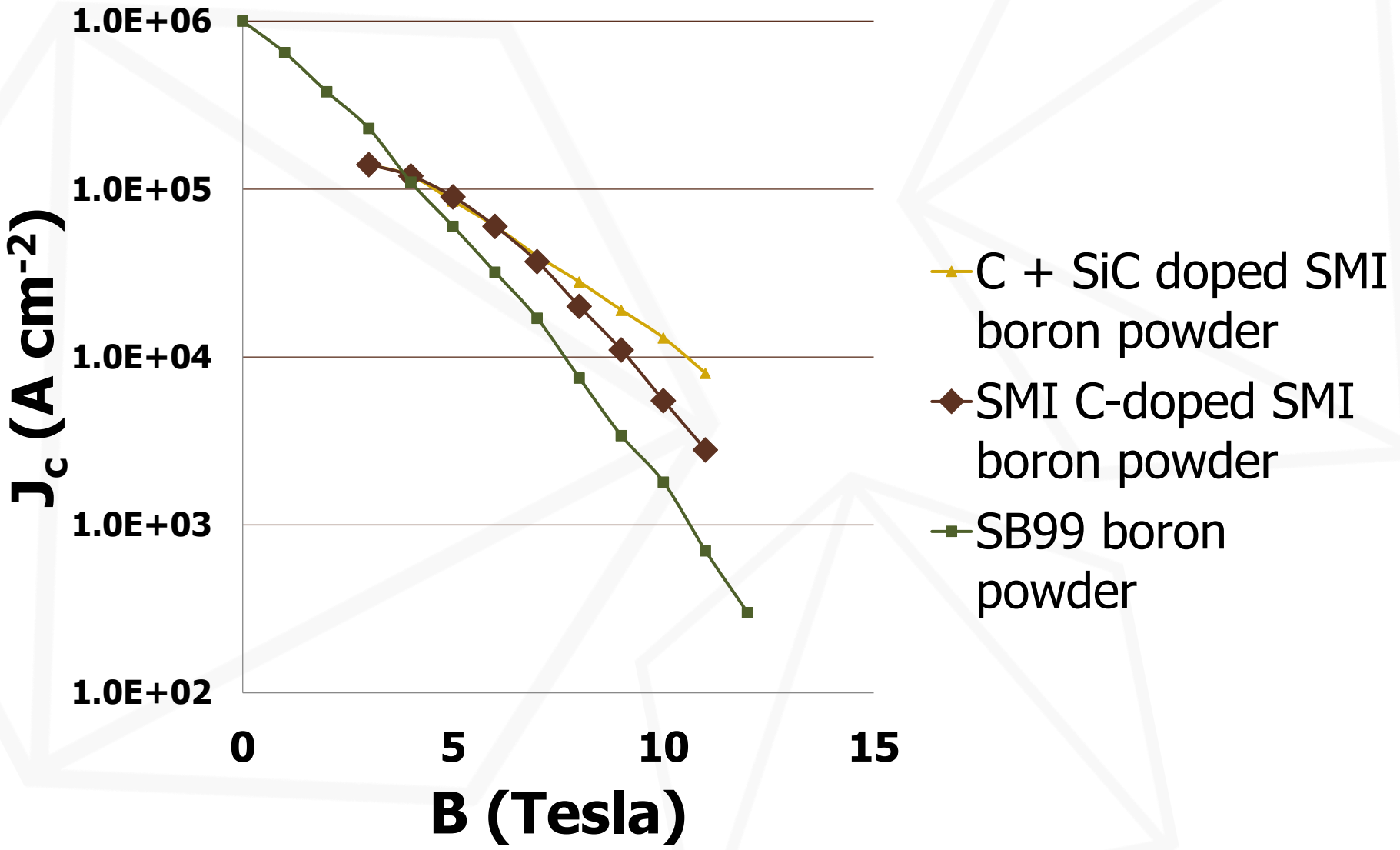
MgB_2 superconducting wires and coils

2nd Generation MgB_2 – breakthrough in wire technology

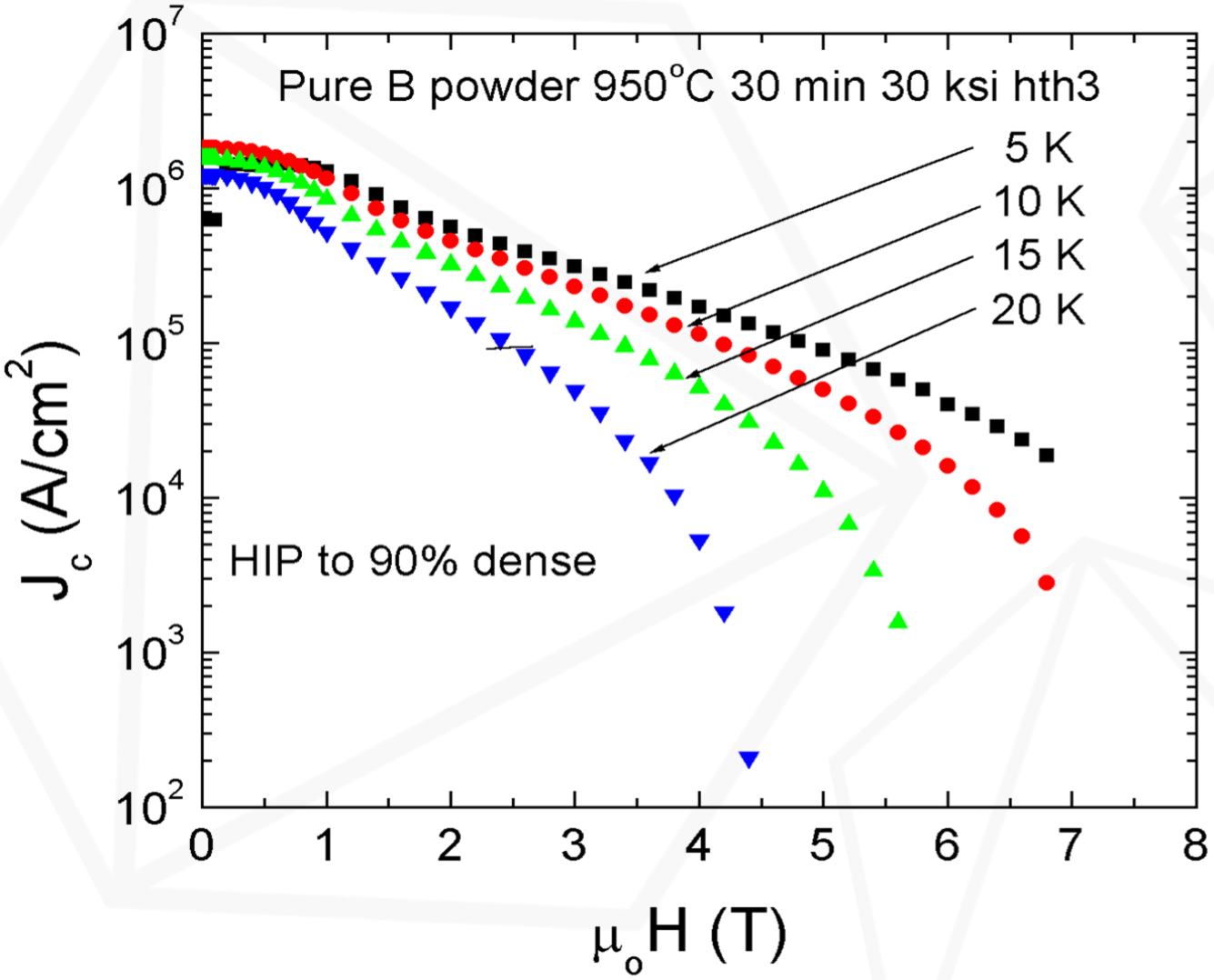


2nd generation MgB_2 superconducting wire made with SMI boron powder displays that highest critical current densities, J_c, thus far reported

Critical current – MgB_2 wire

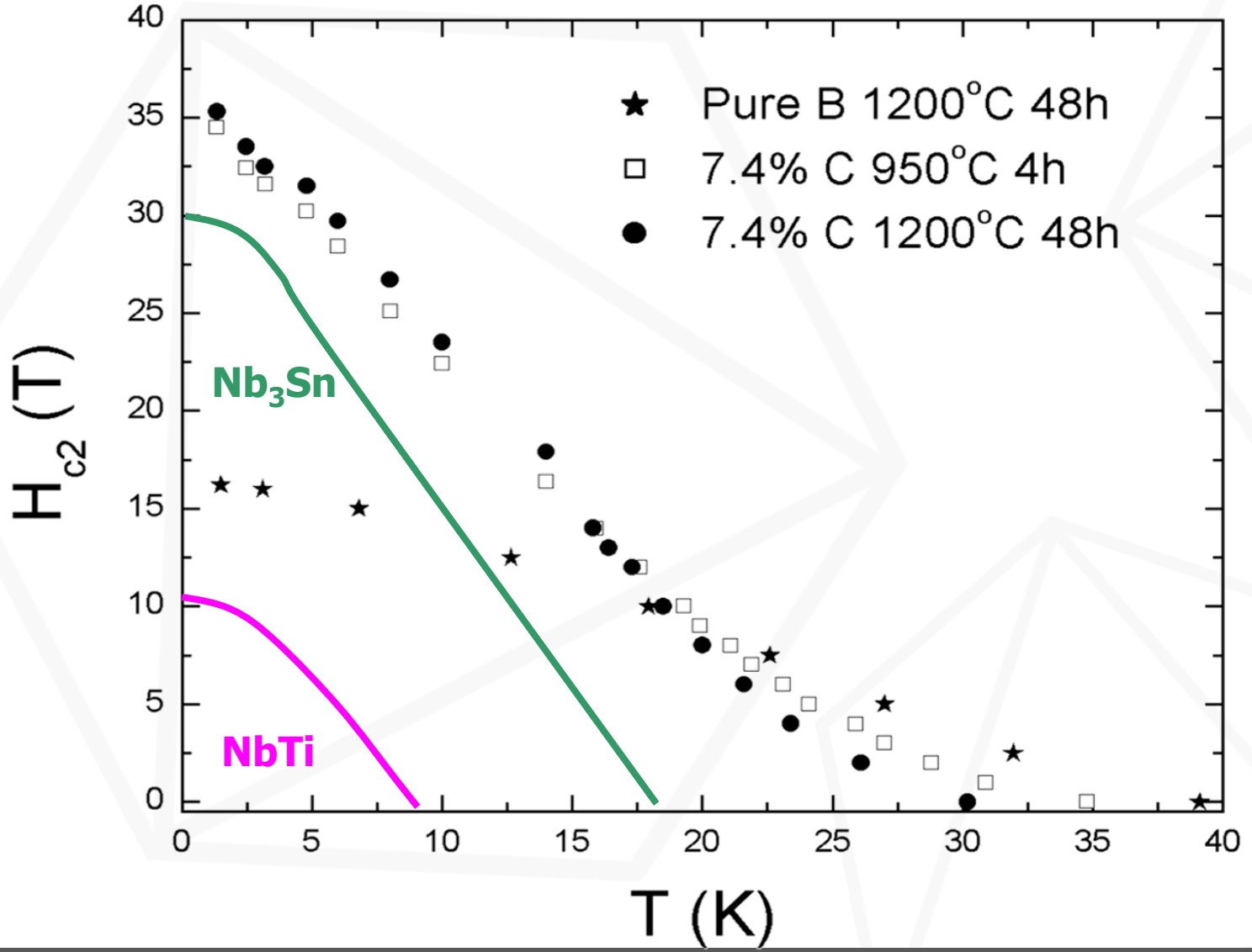


MgB_2 made from RF plasma synthesized doped boron powder



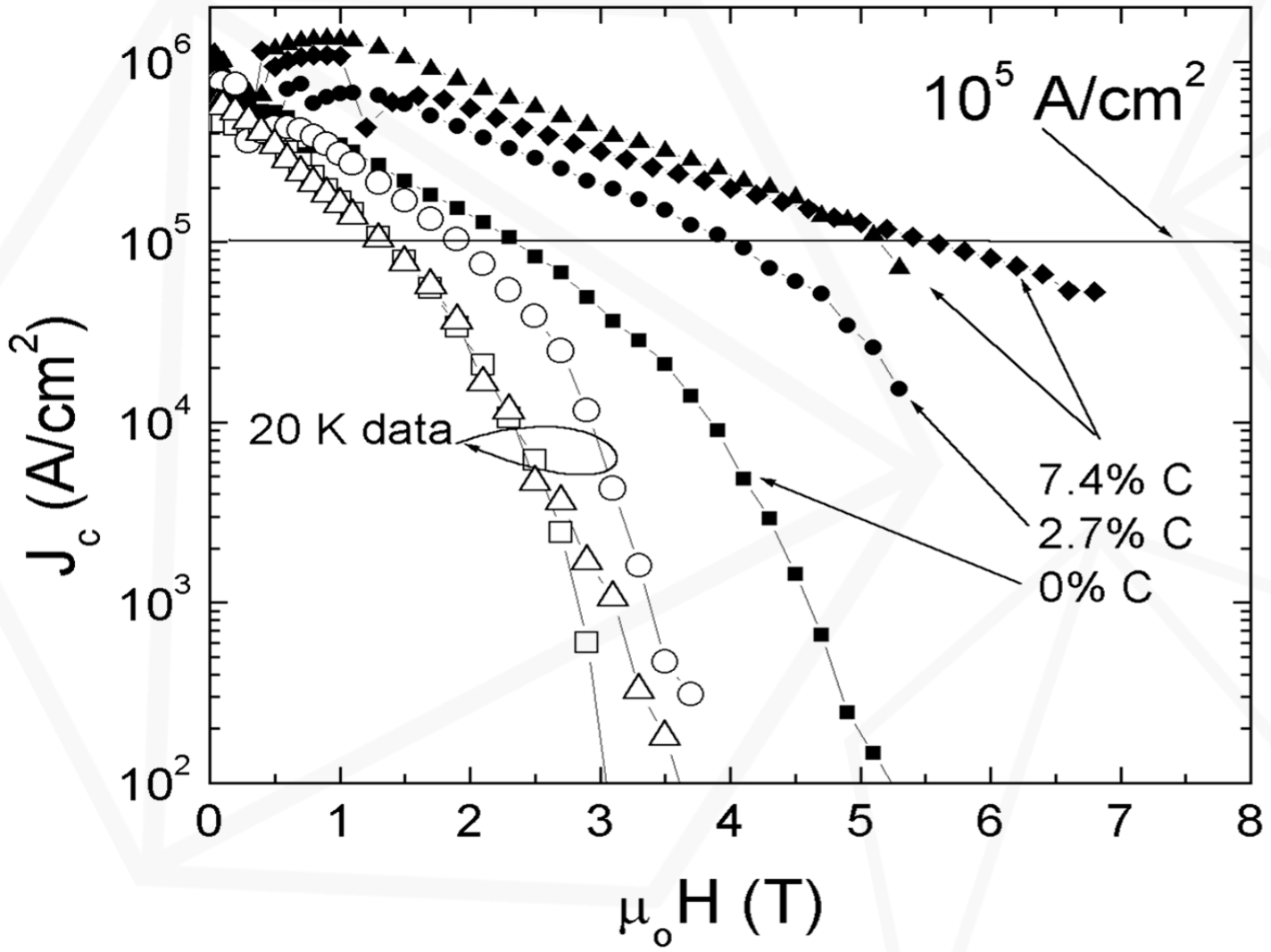
MgB_2 wire made by powder-in-tube (PIT) method using plasma synthesized undoped boron powder. Sheathed wire was HIP'd at 30 ksi at 950°C.

MgB_2 made from RF plasma synthesized doped boron powder



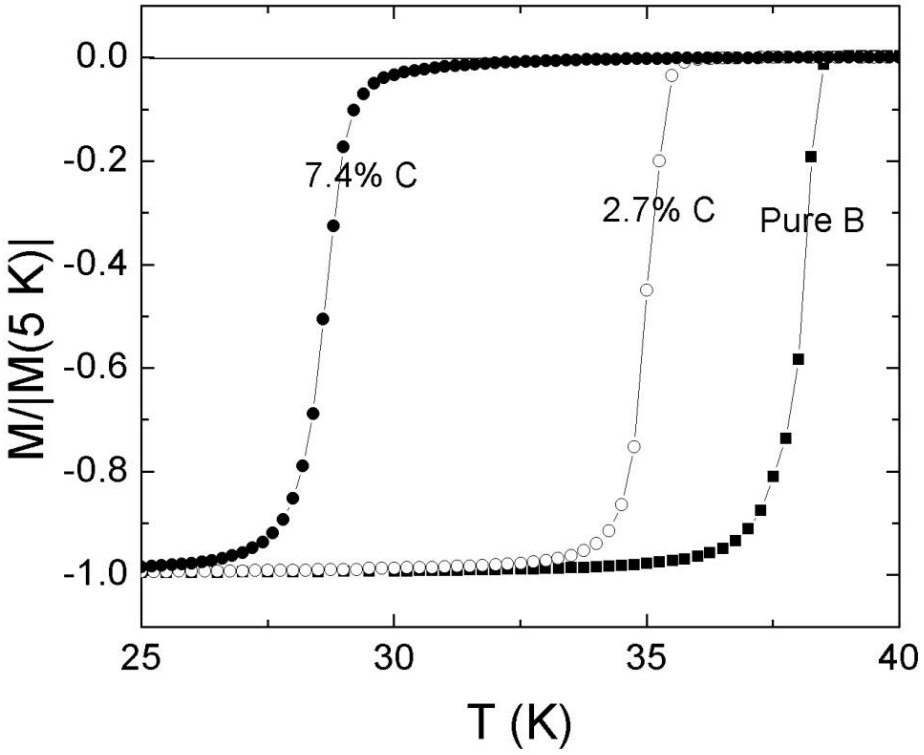
Upper critical magnetic field data for samples prepared from C-doped boron powder showing $H_{c2}(T=0) \sim 37$ tesla, among the highest values reported to date for bulk MgB_2 materials

MgB_2 made from RF plasma synthesized doped boron powder

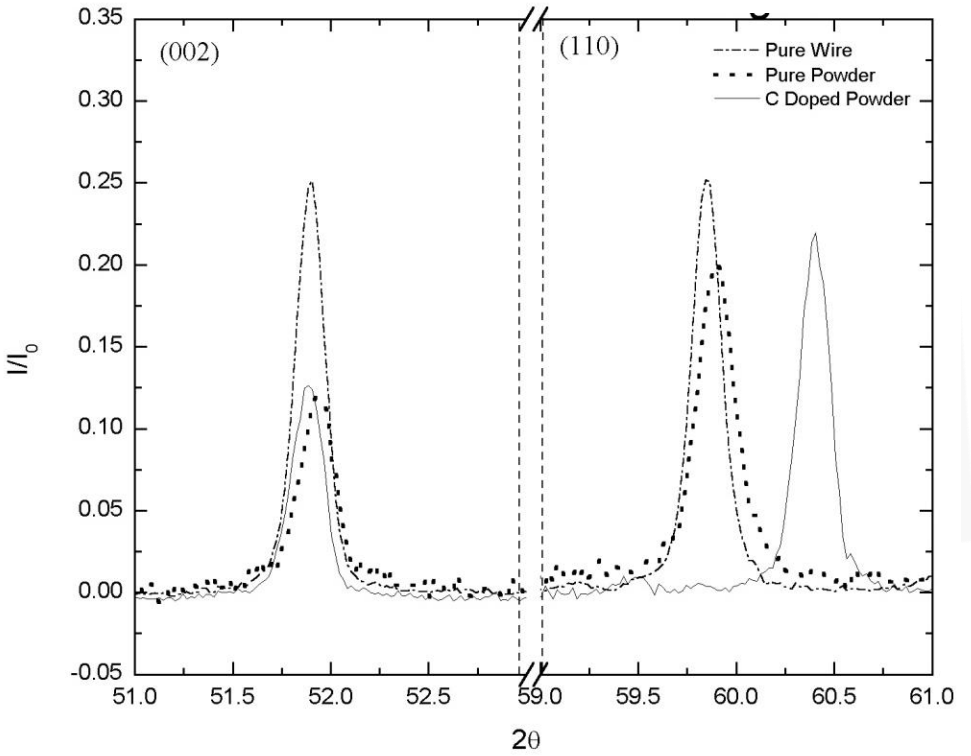


Critical current density vs field at 5K (solid symbols) and at 20K (open symbols) of carbon-doped MgB_2 made from plasma synthesized carbon-doped boron powder

MgB_2 made from RF plasma synthesized doped boron powder



Properties of MgB_2 made from plasma synthesized carbon-doped boron powder showing T_c vs atomic % C

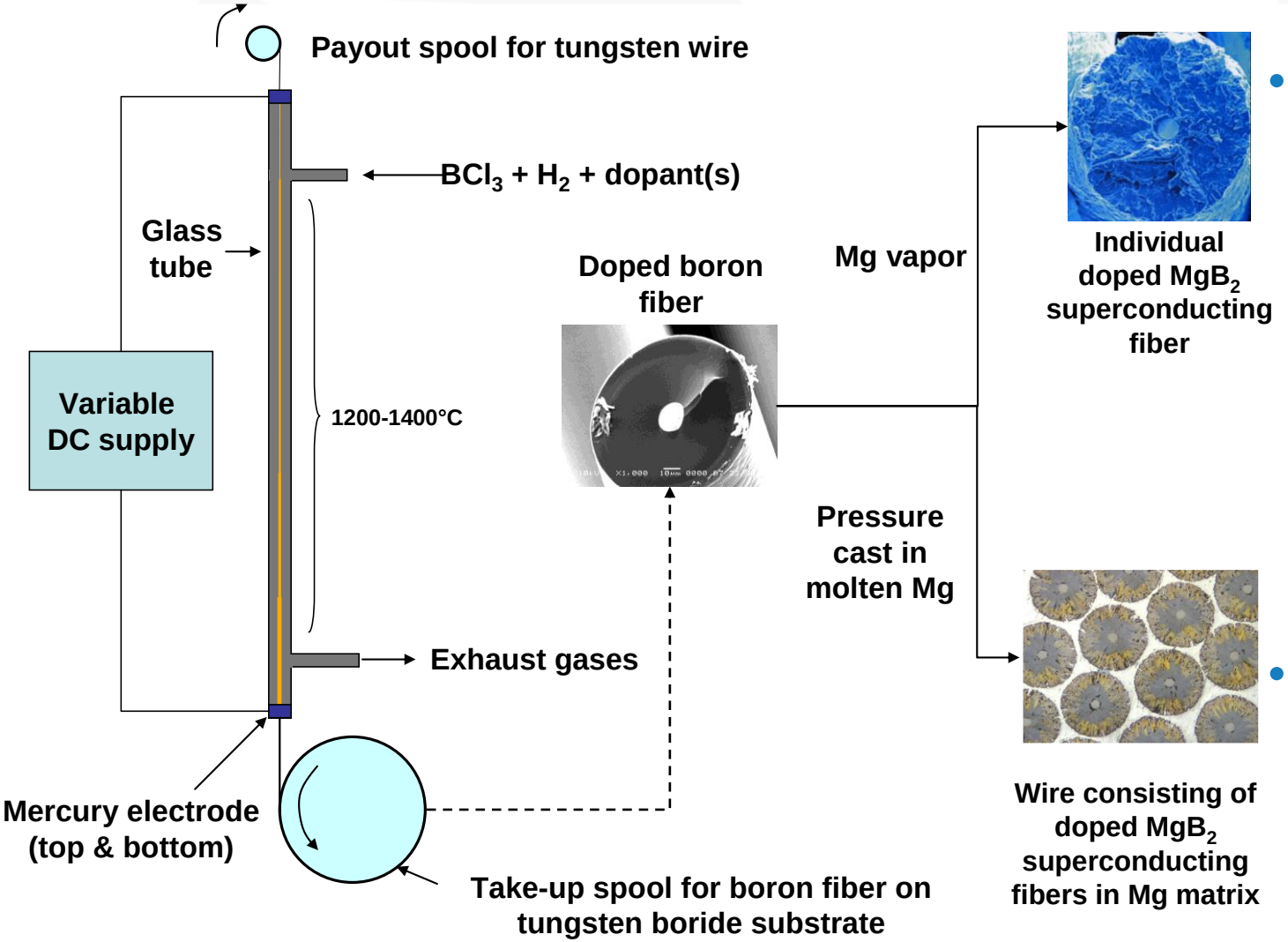


X-ray diffraction patterns (Cu K_α radiation) of MgB_2 made from pure and doped plasma synthesized boron powder; the a-axis shift of the (110) peak corresponds to approximately 7.4% carbon substituted into the MgB_2 lattice.

Cover Art

- MgB_2 made from Specialty Materials boron fiber has been featured on the covers of:
- *Physics Today* (March, 2003)
- *Physics World* (January, 2002)
- *Scientific American* (inside April, 2005 issue)

Historical perspective - MgB_2 from SMI's boron fiber



- Conversion of boron to MgB_2 fiber demonstrated at Ames Laboratory / Iowa State University
- Conversion of boron to MgB_2 composite wire demonstrated at Northwestern University