

Present status of MgB₂ wire manufacturing

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Giovanni Grasso



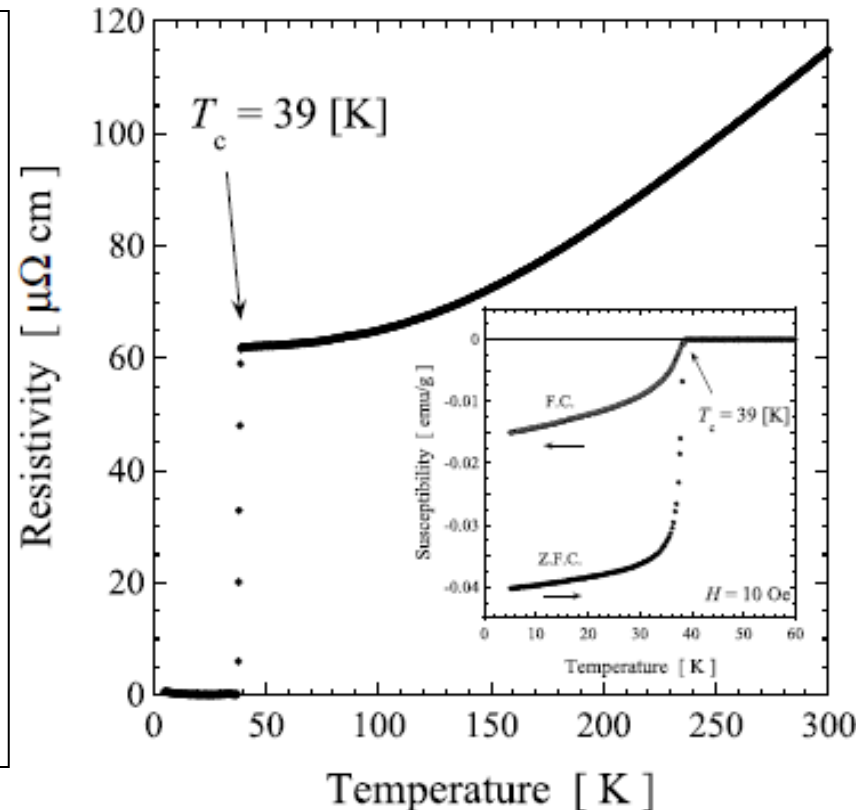
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Superconductivity at 39 K in magnesium diboride



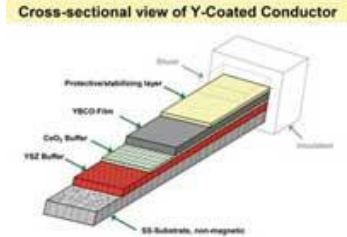
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MgB₂ has opened a new frontier in the physical properties and application of SC
 The limit of T_c in metallic superconductors was considered equal to 30 K
 and this unexpected discovery of high T_c in this
 simple binary intermetallic compound has produced a huge interest around the
 world, with thousands of papers published on MgB₂

	MgB ₂	BSCCO – 1G	YBCO – 2G
Wire type	 <p>Round wire or tape with Nickel-alloy sheath</p>	 <p>Silver sheathed tape</p>	 <p>Thin film on metallic substrate with biaxial texture</p>
T _c (K)	39 K	108 K	90 K
Current carrying capability at 20 K	≈ 1000 A	≈ 1000 A	≈ 1000 A
Superconducting splices	YES	NO	NOT YET
Low cost (<6 €/m)	YES	NO	NOT YET (not likely within 5 years)
Long length (>6 Km)	YES	NO	NOT YET (likely within 5 years)

Columbus has been founded in 2003 as a **start-up** originated from the Italian National Research Council (**CNR**)

- The actual plant is fully operational for **MgB₂** wire production and is completing scaling up
- **MgB₂** compound production is now also fully implemented
- Wire unit length today up to **2- 4 Km** in a single piece -length
- It is scaled up to **20 Km** together with the full scale up of the plant with capacity exceeding **4'000 Km/year**
- Columbus **MgB₂** production for **MRI** has exceeded **700 Km** of fully tested and qualified wires
- Total plant area **4'400 m²** after being increased by further **1'000 m²** in **September 2012** - **40 employees** today



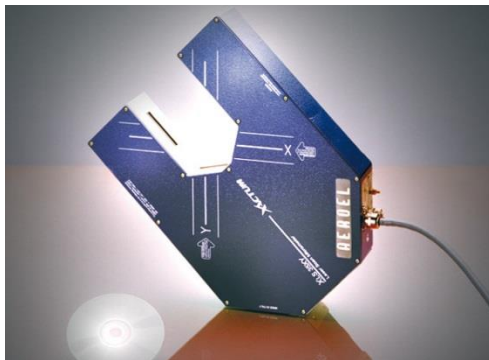


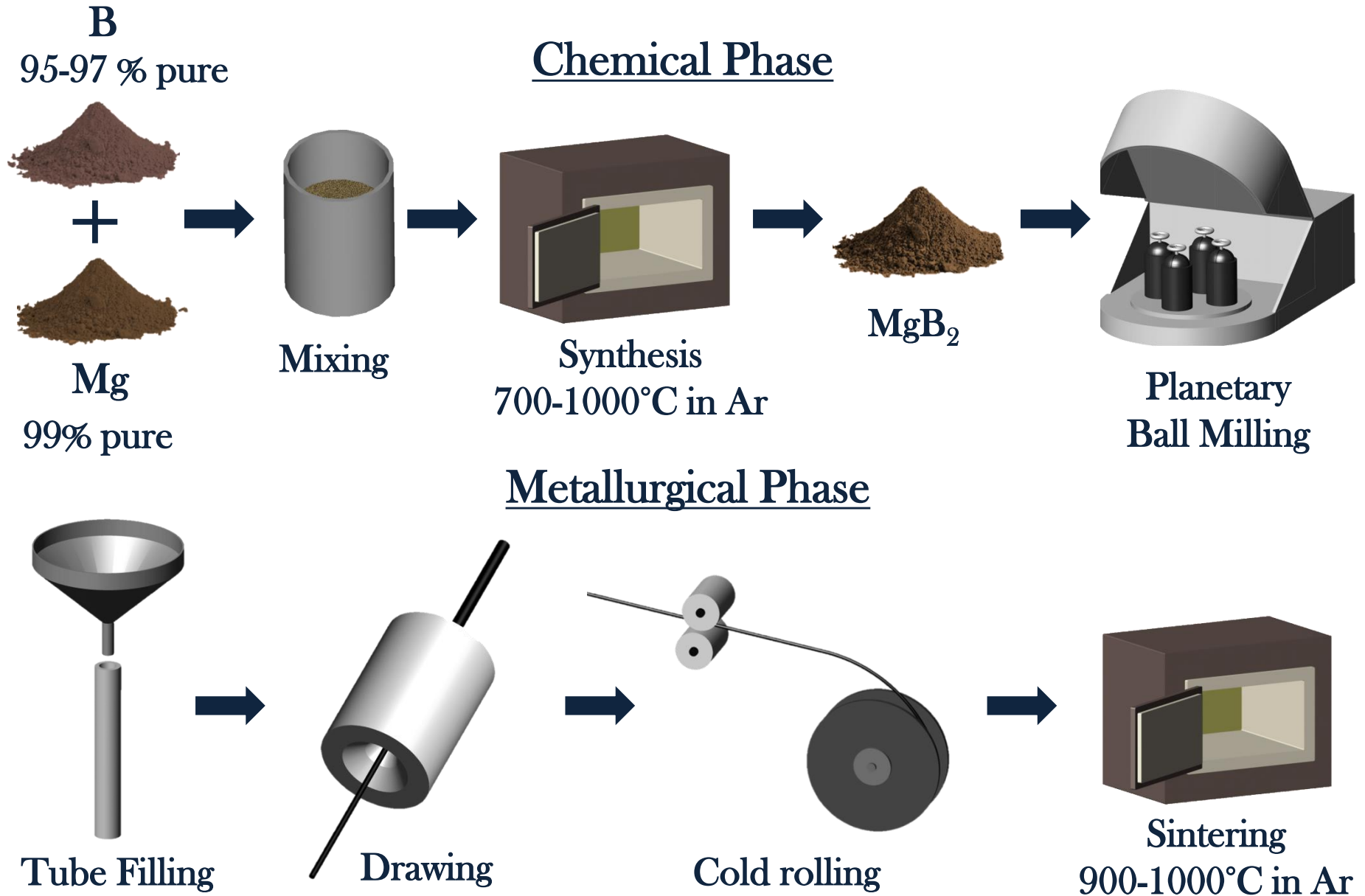
- 39 new machines
- 15 existing machines will be still used over 21,
- 10 main upgrades to the technical infrastructures
- 1 new 2 floors building
- 2.280m² of covered workshop area
- 20 direct production units





- SEM with EDX
- very fast XRD
- Laser particle size analyzer
- Eddy currents defect detector
- Optical stereomicroscopes
- Laser wire size and shape online monitor
- Industrial video cameras for surface defect detection
- Additional cryo-free critical current testing system under construction

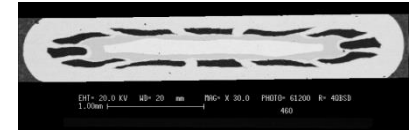




There are **3 different wire formats**: Round, Flat and Sandwich

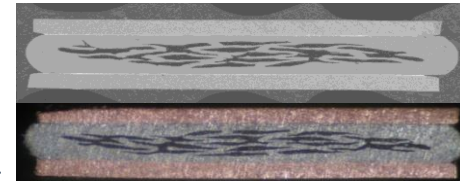
Flat tape

- The flat tape architecture has been the work-horse for Columbus in the past years and it has been the preliminary choice of our customers to start to understand the potential of our material
- Flat tape conductor is mainly used in small bore magnets and low current devices



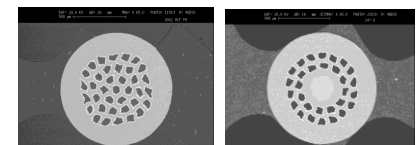
Sandwich conductor

- This architecture is our solution for future magnet and winding applications
- It allows the maximum flexibility in the control of the wire absolute performance and in the amount of Cu stabilization
- Being the Cu stabilizer not subjected to the thermomechanical treatment of the MgB_2 conductor, it's soldered to it in its optimal mechanical and electrical condition



Round wire

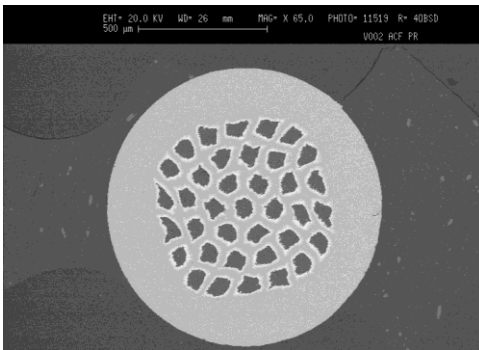
- MgB_2 is currently the only no low- T_c superconductor that can be easily produced in round wire shape with significant transport properties, multifilamentary structure and excellent reliability over long lengths
- Round wires present several advantages, particularly concerning easier solenoid and more complex magnet winding, and absence of anisotropy



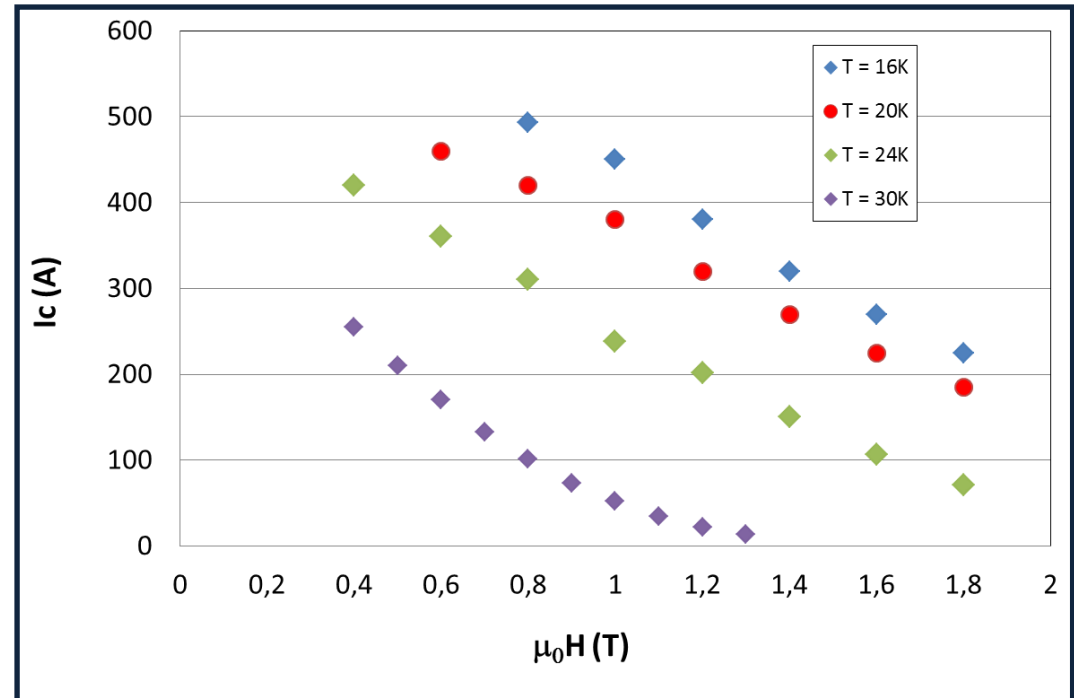
Outer sheath of Monel 400 surrounding 37 MgB₂ filaments protected by a Nb barrier and embedded in a Ni 201 alloy matrix

The unit piece is already 3,5 Km.

The scaling up will lead to a 20 Km unit piece length



Material	Area (mm ²)	%
MgB ₂	0.16	16.5
Nb	0.15	14.6
Ni	0.16	15.5
Monel	0.53	53.4
Copper		
Total	1.00	100
Diameter	1.13	



MROpen has been developed employing the flat tape architecture

MRopen

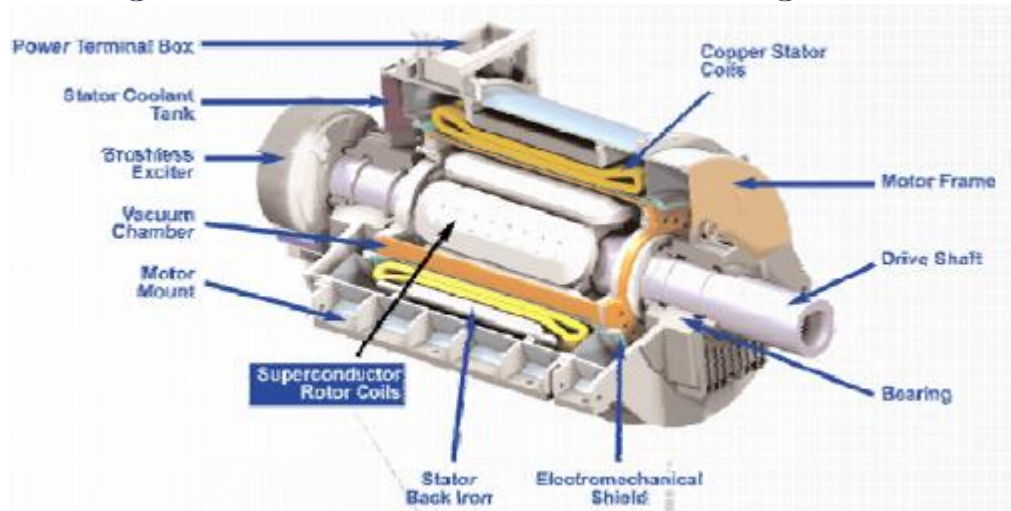


First commercial systems
already installed and fully
operational in hospitals and
private clinics in EU and North
America

- Unique **fully dry** superconducting **MRI** system currently **on the market**
- Based on Columbus **MgB₂** technology
- Unique superconducting **open-sky MRI** system currently on the market
- Very attractive because of its features (scanning **with/no load**, children, **no claustrophobia**, very easy installation and running, ..)
- More than a **dozen systems** produced so far
- Also highly **suitable for remote installation** because electricity is the only requirement to setup/start/run the system - **not suffering** from scattered **power outages** because of large heat capacity

Superconducting Generators

- could offer several cost and reliability improvements over conventional wind turbine drivetrains when scaled up to high capacity (5 MW and larger) and when used in direct drive systems: they do not require a gearbox
- less mass and less volume than conventional as well as PM generators, resulting in an overall reduction in turbine capital costs
- cost advantages produced by such weight savings are most likely to be realized initially in large turbines
- should increase drivetrain reliability by allowing a larger air gap tolerance between rotor and stator as compared to PM generators
- hold the potential of providing high torques in a smaller size and with smaller weight than conventional technologies



10 MW power:
 150 tons MgB_2 generator
 300 tons for PM and
 500+ tons for conventional



- MgB_2 development and production is progressing well
- We believe that MgB_2 cables will represent a very important development for our products
- Dedicated MRI projects are ongoing in several countries
- Total body MRI companies are also starting the implementation of MgB_2 in future commercial systems in order to move to cryogenic-free systems
- New industrial products and research related applications will further help to boost MgB_2 production

Thanks for your attention

