

Advanced HTS Conductors Customized for Fusion

GAMOW Kickoff Meeting
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Venkat Selvamanickam
University of Houston



Team members and roles

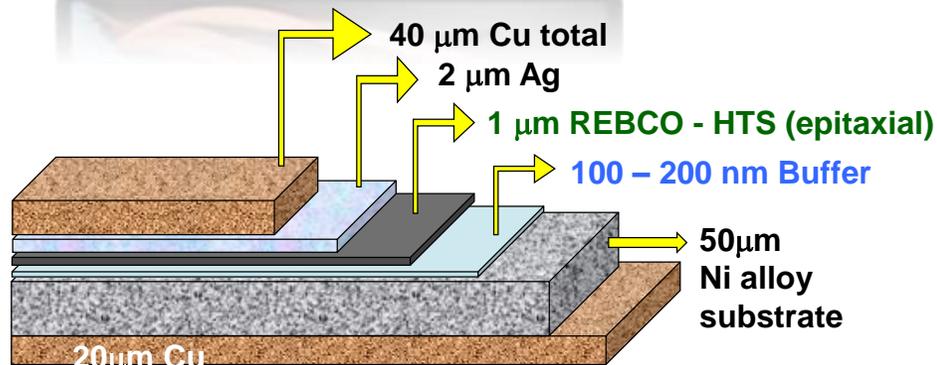
University of Houston:

- ▶ Development of innovative RE-Ba-Cu-O (REBCO) superconductor tape technology for high critical current at 20 K, 20 T and low cost.
- ▶ Development of modified REBCO tape architecture to achieve improved yield strength.
- ▶ **Contributors:**
 - Research Faculty/Scientists: Goran Majkic, Yi Li, Eduard Galstyan
 - Post-doc: Sicong Sun
 - Equipment Engineering: Robert Schmidt, George Pope
 - Research Assistants: Mahesh Paidpilli, Jithin Sai Sandra, Vamsi Yerraguravagari, Chirag Goel

High-level motivation, innovation, and goals of the project

► Motivation:

- REBCO tapes that cost \$10/kA-m enable commercial 200 MW fusion reactors.
- High-strength tapes enable confinement of higher plasma pressure, potentially up to values needed for advanced fuels



► Goals:

- Demonstrate HTS tapes with 10x higher critical current (I_c) and 3x lower unit cost (\$/m) than commercial tapes to achieve a 30x cost reduction based on performance at 20 K, 20 T.
- REBCO tapes with 3.5x yield strength of commercial tapes.

► Innovations:

- Double-sided, thick film REBCO tape technology to increase I_c and precursor utilization efficiency.
- In-line quality control tools for high-yield manufacturing.
- New alloys for REBCO tape lamination for higher yield strength.

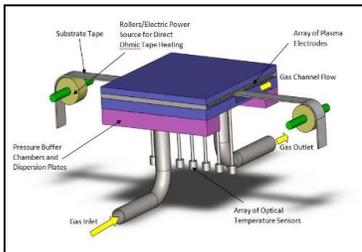
Major tasks, milestones, risks, and desired project outcomes

► Tasks:

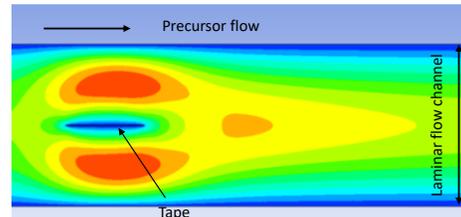
- Double-sided buffer and REBCO tape fabrication using Advanced MOCVD.
- Scale up double-sided tapes to long lengths.
- High-strength alloy lamination.

► Milestones:

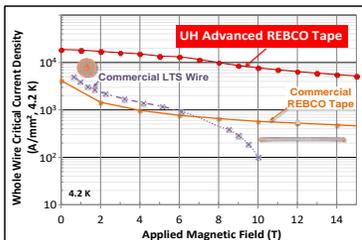
- M2.2 Double-sided buffer tape.
- M3.5 Double-sided REBCO tape with $3.3x I_c$ as commercial tape.
- M6.1 Increase precursor-film conversion efficiency by 6x.
- M7.3 Yield strength of REBCO tape 3x commercial tape.
- M3.7 Double-sided REBCO tape with $10x I_c$ as commercial tape.
- M5.4 Double-sided thick film REBCO tape scaled up to 20-meter length.



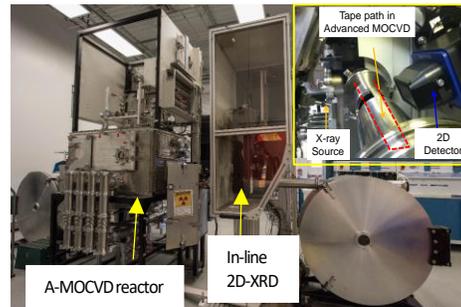
Advanced Metal Organic Chemical Vapor Deposition for 5 μm thick films



Double-sided 5 μm thick films by Advanced MOCVD with 10x I_c and 7x precursor-to-film conversion efficiency



UH 5 μm thick film REBCO tapes with 7x critical current (I_c) of commercial tapes



In-line Quality Control in Advanced MOCVD for high-yield manufacturing

REBCO tapes @ 30x lower cost: \$10/kA-m at 20 K, 20 T

► Risks:

- Epitaxial growth of REBCO films as thick as 5 μm on both sides of tape.
- Mechanical properties of double-sided REBCO suitable for compact fusion magnets.
- Adoption of a different type of REBCO tape by compact fusion system manufacturers.

T2M and aspirational follow-on plans

Metric	State of the Art	GAMOW HTS tape
<i>HTS Conductor Cost</i>	<i>\$300/kA-m @ 20K,20T</i>	<i>\$10/kA-m</i>
<i>Conductor Cost for 200MW Fusion system</i>	<i>\$1200M</i>	<i>\$40M</i>
<i>Yield strength</i>	<i>700 MPa</i>	<i>2.5 GPa</i>

- \$10/kA-m tape cost will enable an early commercialization of fusion power plants, cost competitive with other power sources.
- 3 – 4 GA-m needed for commercial fusion device.
- High capital cost (\$10M) for REBCO production of 1000 km/yr.
- Using 10x I_c tape, the tape quantity for a commercial system will be reduced ~10x, which will greatly reduce commercializing risk for compact fusion.

► Test & deployment plans/aspirations

- Advanced HTS conductors can benefit all commercial fusion concepts.
- Partner with REBCO tape manufacturers to scale up technology to commercial manufacturing.
- Deliver REBCO tapes to compact fusion system manufacturers for evaluation and feedback.
- Engage compact fusion system manufacturers and REBCO tape manufacturers on informal advisory board.