Carbon conductors for lightweight motors and generators

DE-EE0007865

Rice University, University of Maryland, DexMat, Irvin Global Industries

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Washington, D.C.
July 17-19, 2018

Overview

Timeline

- Awarded 3/30/2017
- Projected End date Sept 2019
- Project 45% complete

Budget

	FY 16 Costs	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 19-Project End Date)
DOE Funded	_	$118k	$390k	$492k
Project Cost Share	_	$0k	$94k	$69k

Barriers

- Aligning the carbon nanotubes in the cable without breaking connections
- Methods to increase length of individual carbon nanotubes can result in lower quality structures
- Dopants to improve electron transfer between nanotubes don't necessarily end up where you want them

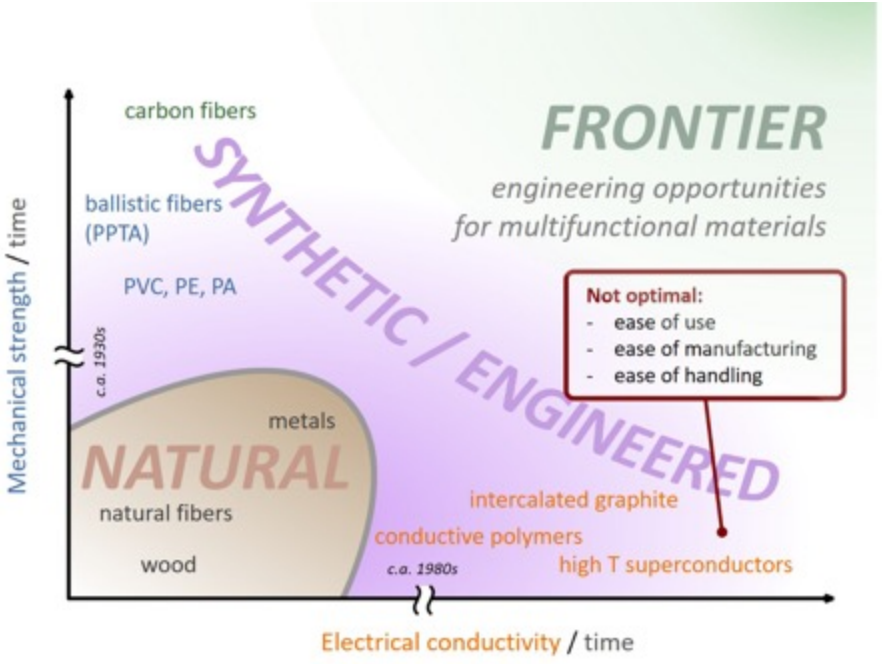
Partners

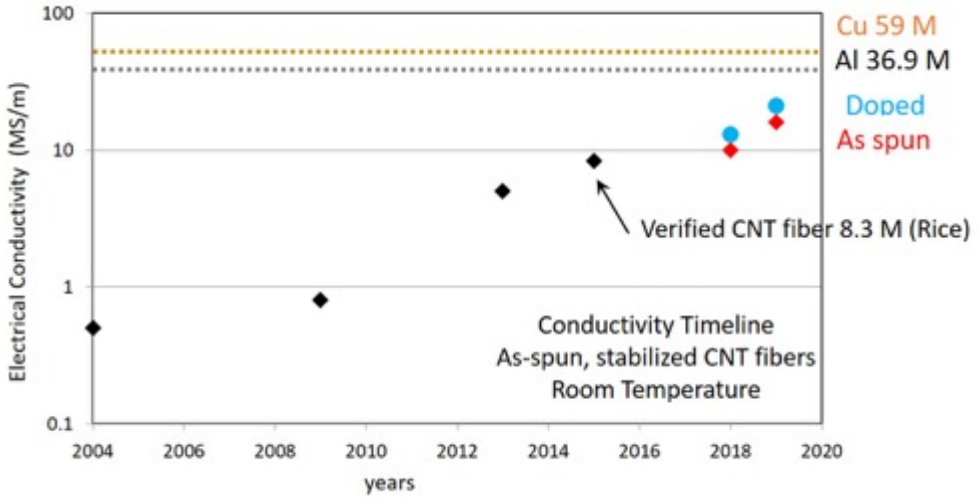
- University of Maryland
- Dexmat
- Irvin Global Industries

Project Objective

Problem: metals are presently used as motor winding conductors; they are heavy, prone to corrosion, and fragile at small size → Need for a lightweight, strong conductor

Goal: Demonstrate high conductivity carbon nanotube (CNT) conductors as winding material for electrical motors; develop scalable manufacturing process for CNT conductors



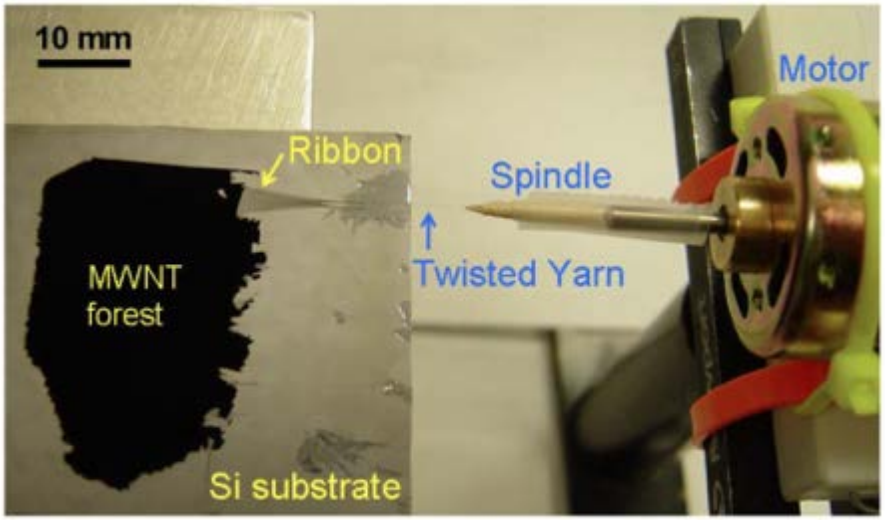


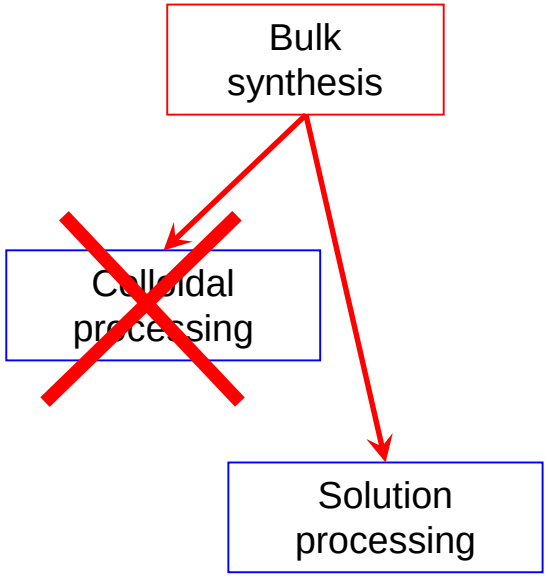
Challenges:

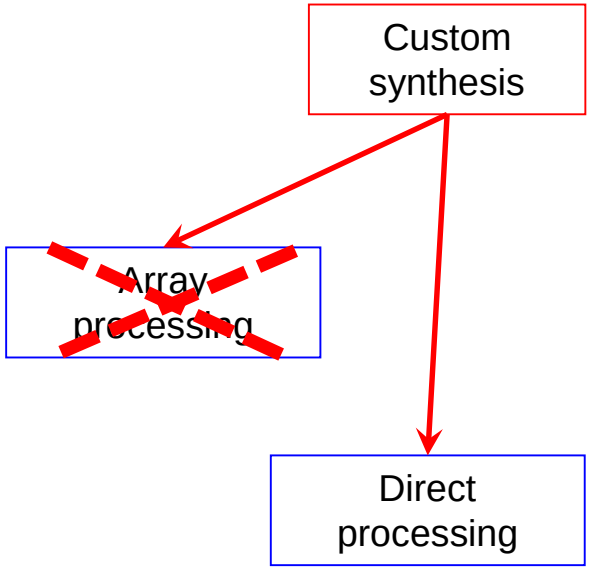
- Produce high quality CNTs → reach target electrical conductivity
- Translate properties of CNT fibers from lab to large scale
- Optimize CNT doping and conductor insulation for high-temperature stability

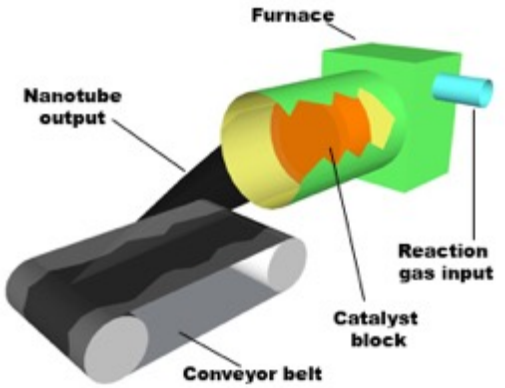
Technical Innovation

Limits of current practice:



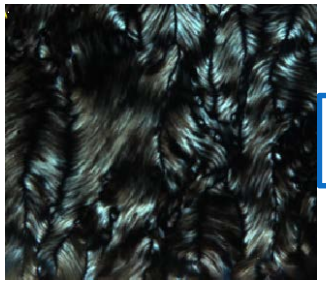






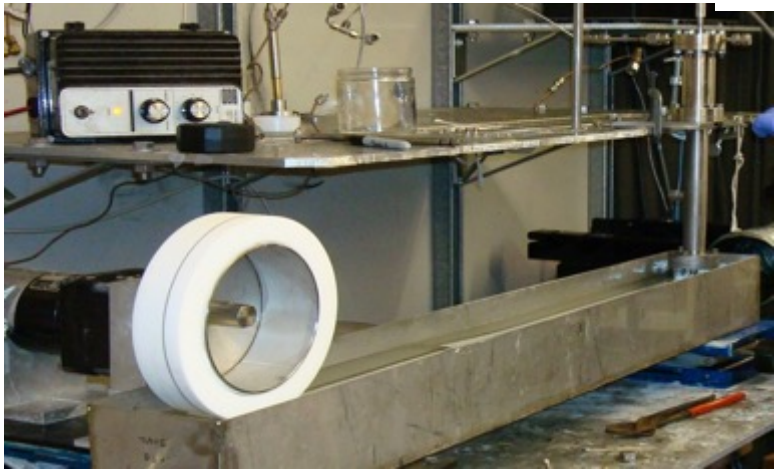
Nanocomp
Reactor

Technical Innovation



Mixing CNT and acid

Synthesis of CNTs or commercial sources



Insulate

Drying

Spin dope loading

Extrusion

Coagulation

Winding

Washing

Our approach: scalable & allows independent optimization of CNT synhesis & fiber spinning

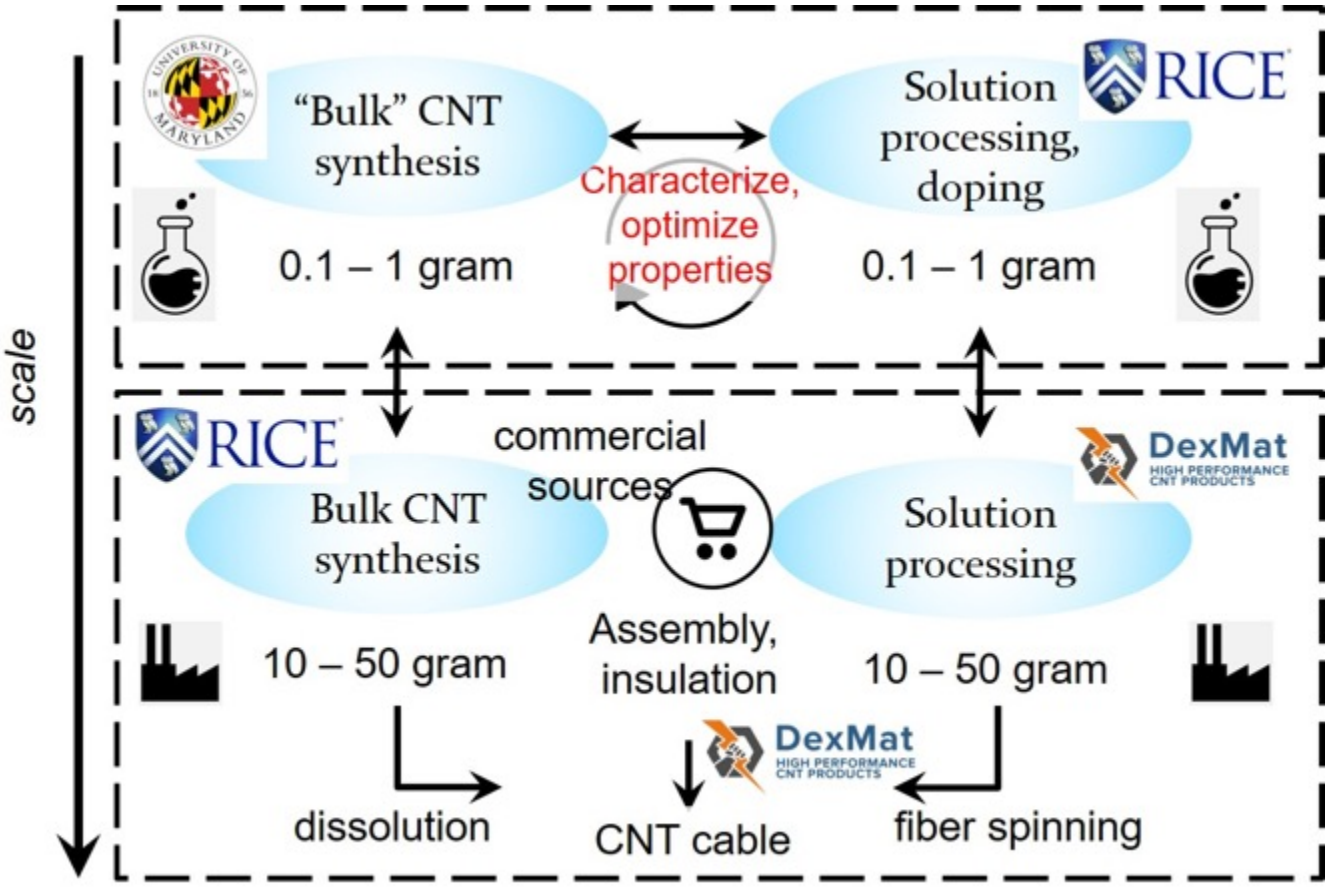
UNIT OPERATION approach: each step can be optimized separately

Cost aspect:

- Optimal CNT synthesis to lower cost of CNTs; our solvent is widely used in industry and inexpensive
- Wet fiber spinning is cheaper than solid state spinning

Behabtu, Ma, Pasquali, et al, Science, 2013

Technical Approach



Potential project risks and unknowns:

Low performing CNTs produced "in house"

→ Work with CNT manufacturers and purchase their material

→ Work in parallel between Rice and University of Maryland to obtain optimal recipes

→ Introduce CNT synthesis industry experience (Glen Irvin) in the team

Transition (beyond DOE assistance)

Motor market: $99.85 B in 2014 and expected to reach **$141.7 B** in 2022
(*source: Electric motor market analysis, Grandview research:2015*)

CNT conductors for winding material:

- Lightweight
- Electrically and thermally conductive
- High flex fatigue resistance
- Resistant to corrosion

Application in motors - advantages:

- Increase energy efficiency → energy saving
- Avoid the need to rewind due to failures
- Lightweight motors

Commercialization approach:

DexMat
HIGH PERFORMANCE CNT PRODUCTS

Scale up of CNT fiber conductor

REGAL BELOIT, TECO, Westinghouse, SIEMENS, LEROY SOMER, TOSHIBA

OEMs for motor producers and rewinding industry

Questions?