Next Gen Low-Carbon (Low-Cost) Cement

Enabled by Carbon Nanotube Hybrids

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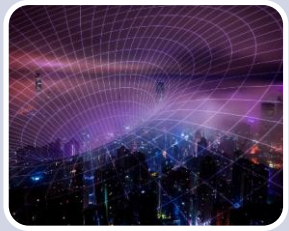
Advanced Materials

for SAFER, MORE CONNECTED and SUSTAINABLE LIVING



Safer Driving	More Connected	Abundant Water	Better Batteries	Greener Concrete

Carbon Nanotubes printed on substrates to enable highly transparent and flexible heaters for ADAS and transparent 5G antennas

Vertically-Aligned Precision Nanotube Membranes for Water purification

Nanotube Hybrid Enhanced materials enabling higher performance EV Batteries and Low-Carbon (Low-Cost) Cement

AgeNT™

CHASM H_2O

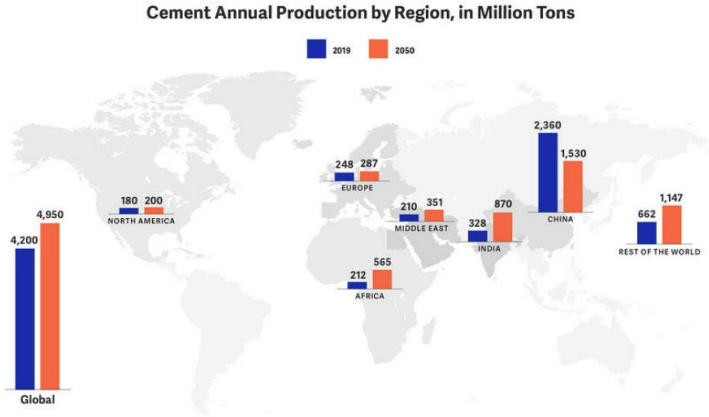
NTeC™

Nanotube-Enabled Low-Carbon Cement

Carbon Reduction Opportunity

30 Million MT CO2 emission reduction in USA alone

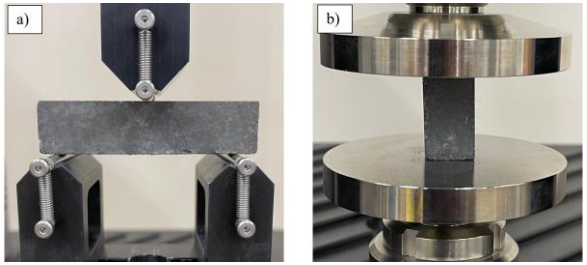
Using amounts as low as 0.1%, CHASM's NTeC™-C provides a substantial boost to overall mechanical properties, creating the opportunity for high volume (over 50%) replacement of clinker with other SCMs like fly ash or slag and thereby enabling "**Low-Carbon and Low-Cost Cement**".



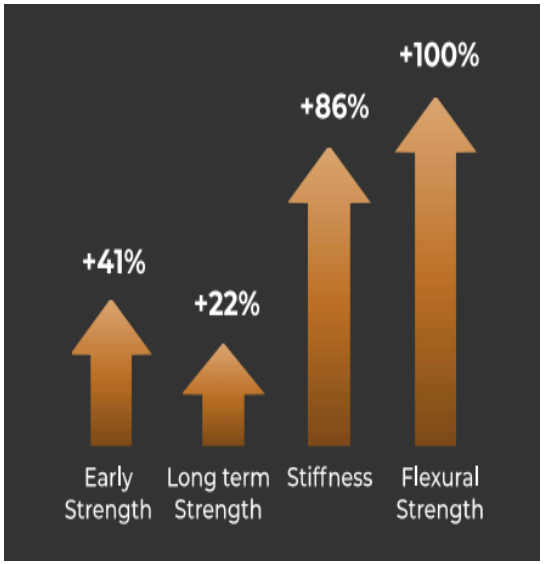
Low-Carbon (Low-Cost) Solution

NTeC-C Concept Proven to Enable Green & Smart Concrete

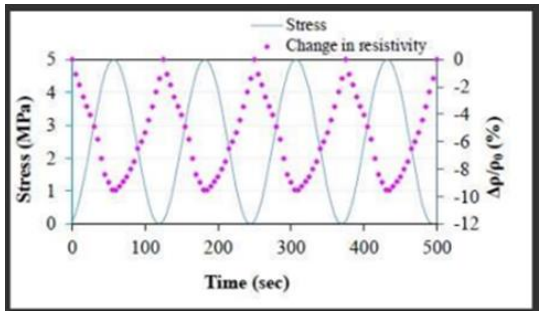
DR. MARIA KONSTA GDOUTOS
CENTER FOR ADVANCED CONSTRUCTION MATERIALS
UNIVERSITY OF TEXAS ARLINGTON



0.1-0.15% NTeC-C by wt. of Cement



High Mechanicals, enabling Green



Self-sensing, enabling Smart "Internet of Concrete"

Nanotube Hybrids substantially increase the mechanicals to permit high-volume clinker replacement

NTeC-C Concept Proven to Reduce Carbon (and Cost)

Hypothesis:

- Replacing 30% Cement with Fly Ash will reduce/effect properties depending on Grade (F and C)
- 0.1% NTeC would compensate any drop in properties due to cement substitution

Results with only 0.1% NTeC: **Hypothesis Validated**

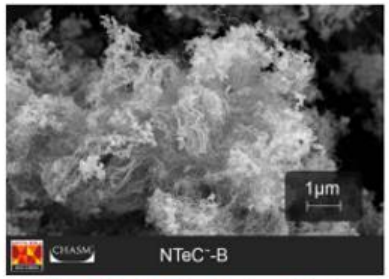
- **Compressive Strength:**
  - Grade F Fly Ash: Compensates the -17% drop to -8% baseline
  - Grade C Fly Ash: Further enhances the 11% increase to 21% above baseline
- **Flexural Strength:**
  - Grade F Fly Ash: Compensates the -10% drop to 11% increase above baseline
  - Grade C Fly Ash: Further enhances the 12% increase to 28% Increase above baseline
- **Stiffness/Young's Modulus:**
  - Grade F Fly Ash: Compensates the -10% drop to 12% Increase above baseline
  - Grade C Fly Ash: Further enhances the 11% increase to 25% Increase above baseline

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy
ADVANCED MANUFACTURING OFFICE
OAK RIDGE National Laboratory

Signed MoU with ORNL/DoE

Collaborating with Industry & Academia partners to optimize performance and cost

NTeC Carbon Nanotube Hybrids - Enables Easy DISPERSION



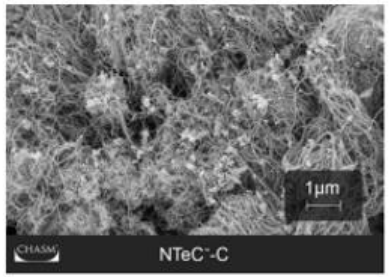
NTeC-B = CNT + Carbon Black

NTeC-B= Carbon Nanotubes + Carbon Black

1. Battery Materials
   - Faster charging, higher power
2. Rubber Additives
   - Longer-lasting Tires
3. Conductive Coatings
   - Tinted Antistatic & ESD coatings

ADITYA BIRLA BIRLA CARBON

Being Commercialized exclusively by Birla Carbon



NTeC-C = CNT + Silica

NTeC-C= Carbon Nanotubes + Cementitious Particles

1. Green Cement/Concrete
   - Low Carbon and Low Cost Cement
2. Smart Concrete
   - Self Sensing for Health Monitoring

✓ **SELF DISPERSING**

✓ **SCALABLE**

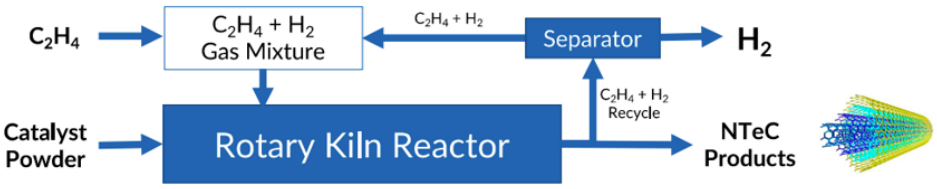
✓ **SUSTAINABLE**

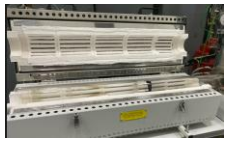
Success of NTeC-B being leveraged to accelerate NTeC-C beyond TRL-5

Building Towards the World's Largest Nanotube Capacity…

CHASM's proprietary nanotube manufacturing process

- Rotating Kiln reactor, which is scalable, sustainable, capital efficient
- Fabricate 1500 MT/yr capacity reactor in a repeatable, "modular" unit
- Build unit to process nanotubes into "pre-dispersed micro-encapsulated NTeC-C





2020: 100 kg/yr R&D reactor

2022: 50 Mt/yr Pilot reactor

30X

2024: 1500 MT

$6 Million+ CAPEX

Deploys 750,000 MT of SCMs/yr in Cement

10+X

2028: 15000MT+

Deploys 7.5 Million MT of SCMs/yr in Cement

…to substantially reduce the carbon footprint of Concrete globally

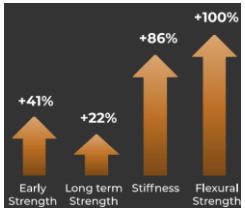
Crossing the Chasm: Proof of Concept → Market Readiness

Proof of Concept ➡ Joint Development Agreement with OEMs 2022-2024 ➡ Commercial Deployment

Synthesize NTeC-C hybrids

TRL 1-4

Validate NTeC-C performance in University Laboratory



Validate basic performance in Customer's Laboratory
TRL 5

Optimize NTeC-C hybrids for Customer's environment
TRL 6

Integrate NTeC-C hybrids inside Customer's operations, Validate prototype and Qualify
TRL 7-8

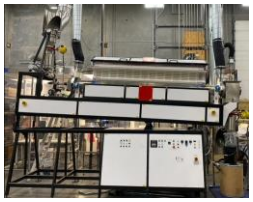
Integrate NTeC-C at Scale. Purchase agreements
TRL 9

Manufacturing Readiness

100 kg/yr R&D reactor

2021-22

$1 Million



50 Mt/yr Pilot reactor

2022-23

$10 Million+

1500 MT in a 60' container/skid

Lab scale Dispersion

Scalable Dispersion

Concentrated Dispersions

Encapsulated NTeC-C and/or Masterbatch of activated Cement

Impact of NTeC-C: Low-Carbon and Low-Cost

CO2 saved and Cost Saved

- *Baseline binding material and cost = 100% OPC at $50 USD/MT*
- *CO2 footprint of 1 MT OPC = 0.7 MT CO2*
- *New Binding Material =* **50%** *OPC +* **50%** *SCMs +* **0.1%** *NTeC-C*
- **CO2 saved for every 1 MT of binding material = 0.35 MT CO2**
- *New Cost with $5 USD/MT for SCM and $7.5 USD of NTeC-C= $35 USD/MT*
- **Cost reduction: $15 USD/MT** *(30% of 100% OPC baseline)*

Example 1: One MILE of highway

- *Needs ~16,000 m3 of Concrete with over 6,400 MT of binding material*
- **Deploying only 6.4 MT of NTeC-C saves over 2240 MT of CO2**

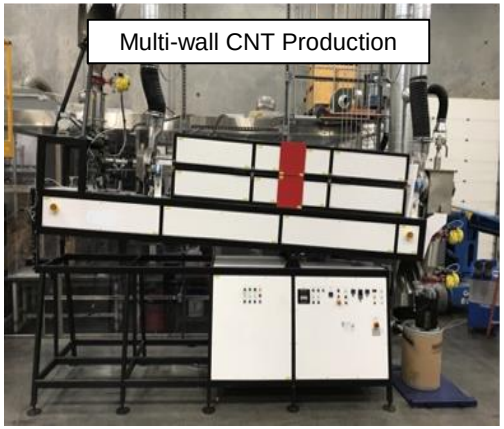
Example 2: A typical 0.75 Million MT/yr OPC plant

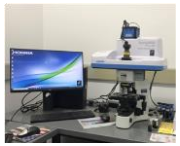
- *Needs 1,500 MT of NTeC-C (One Reactor)*
- **CO2 reduced/Plant= 525,000 MT/year/plant**

Every 1% global adoption is a 14 Million MT/year CO2 reduction potential

- **Needs 27 Units of CHASM's 1500 MT/year units, producing 40,000 MT/year of NTeC**
- **Deploying 20 Million MT of SCMs (fly ash, slag...) in Low-Carbon (Low-Cost) Cement**

Nanotube Manufacturing and R&D Center - Norman, OK





ISO 9001 QMS Certified ASR American Systems Registrar

NTeC™

CHASM™

Let's Create Low Carbon (Low Cost) Cement Together.