



Introduction CarbonX  
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# Meet CarbonX

## A Revolutionary New Carbon

- Carbon nanofibers linked into a structured network
- Boosts material performance
- Scalable, low cost production
- A high value added, durable material



# Carbon Building Blocks of Our World

## Natural vs. Synthetic

Plants & trees

Oil & gas

Graphite  
Diamond

Charcoal  
Soot

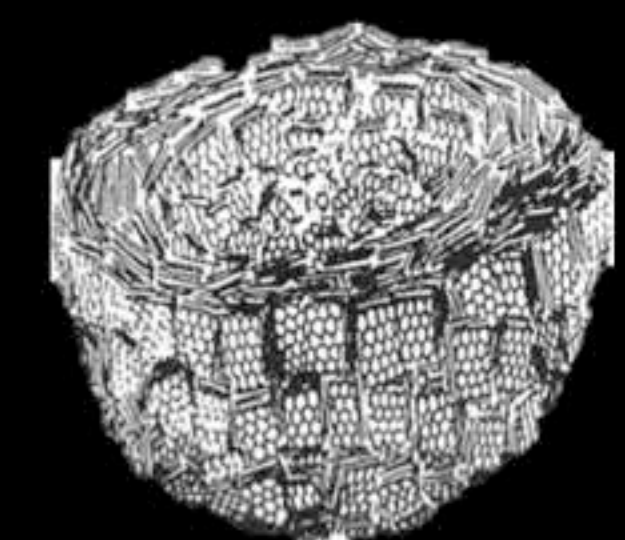
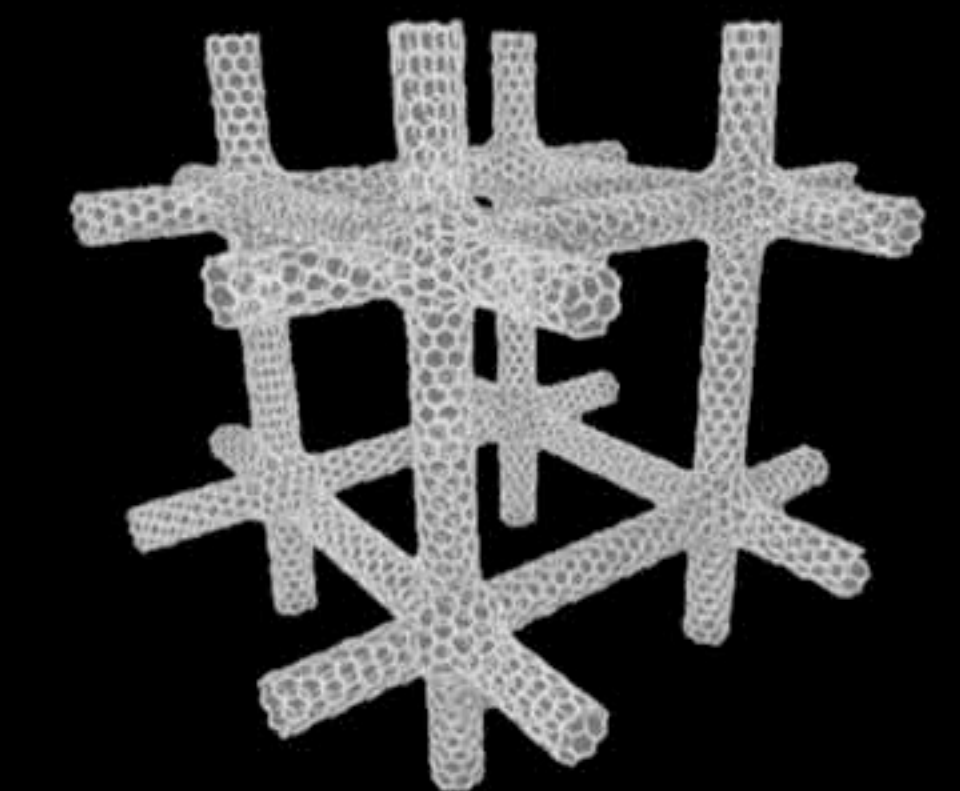
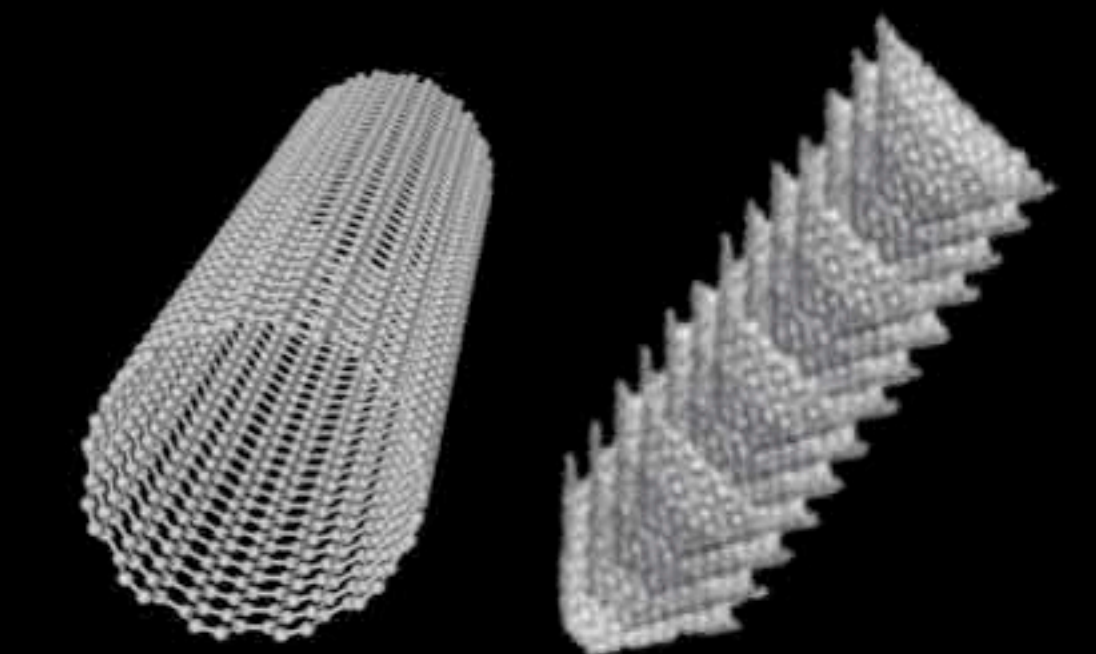
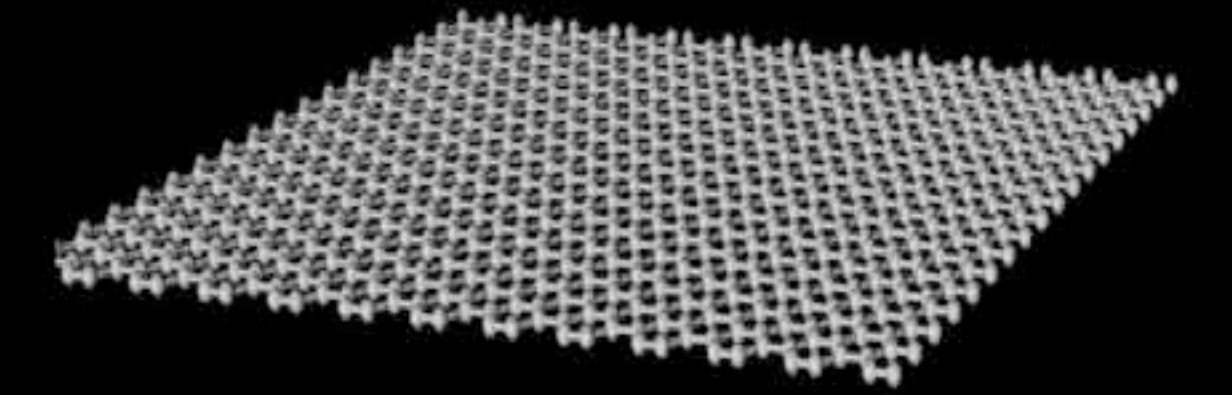
Graphene  
0.1 nm

Carbon nanofiber/tubes  
3 nm – 100 nm

Carbon nanofiber network  
3 nm – 500 nm

Carbon black  
10 nm – 500 nm

Carbon fiber  
>1,000 nm





# Exciting Product Applications

Global Market Demand Estimated at US\$ 2.5bn\*



Composites

US\$ 800m



3D printing

US\$ 50m



Tires

US\$ 1bn



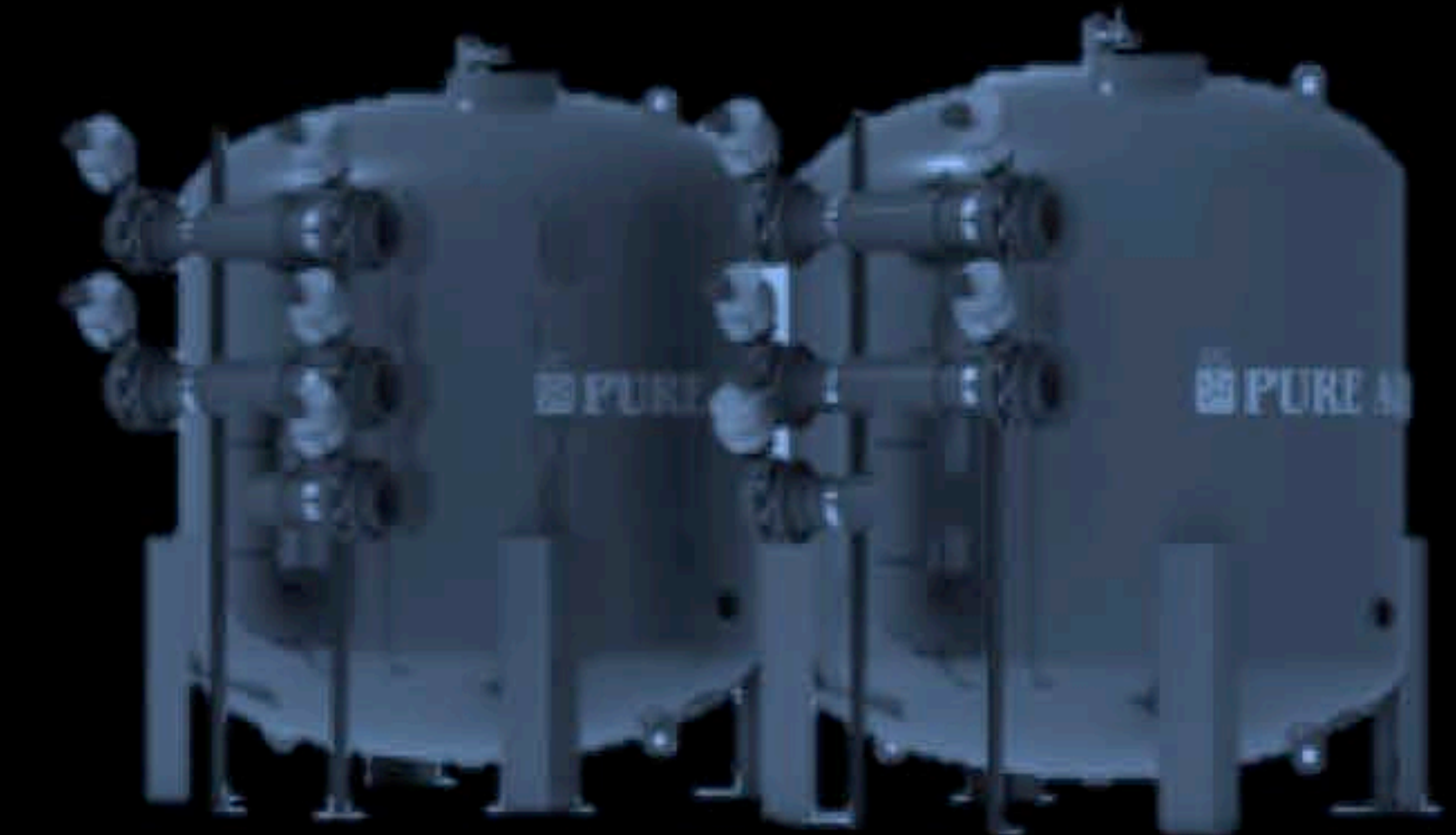
Coatings

US\$ 180m



Batteries

US\$ 100m



Purification

US\$ 350m

\* Assumes CNNs can substitute as a superior or lower cost alternative 10% of existing carbon or other reinforcement/conductive materials



# Favorable Market Conditions

## CarbonX Ties-in to Four Key Global Trends

- **Carbon Productivity**  
Increase the value generated from fossil carbon
- **Light-weighting**  
Reduce CO<sub>2</sub>-emissions following EU directives
- **Miniaturization**  
Manufacture ever smaller products
- **Recyclability**  
Re-process and re-use of materials



# Strong Product Demand

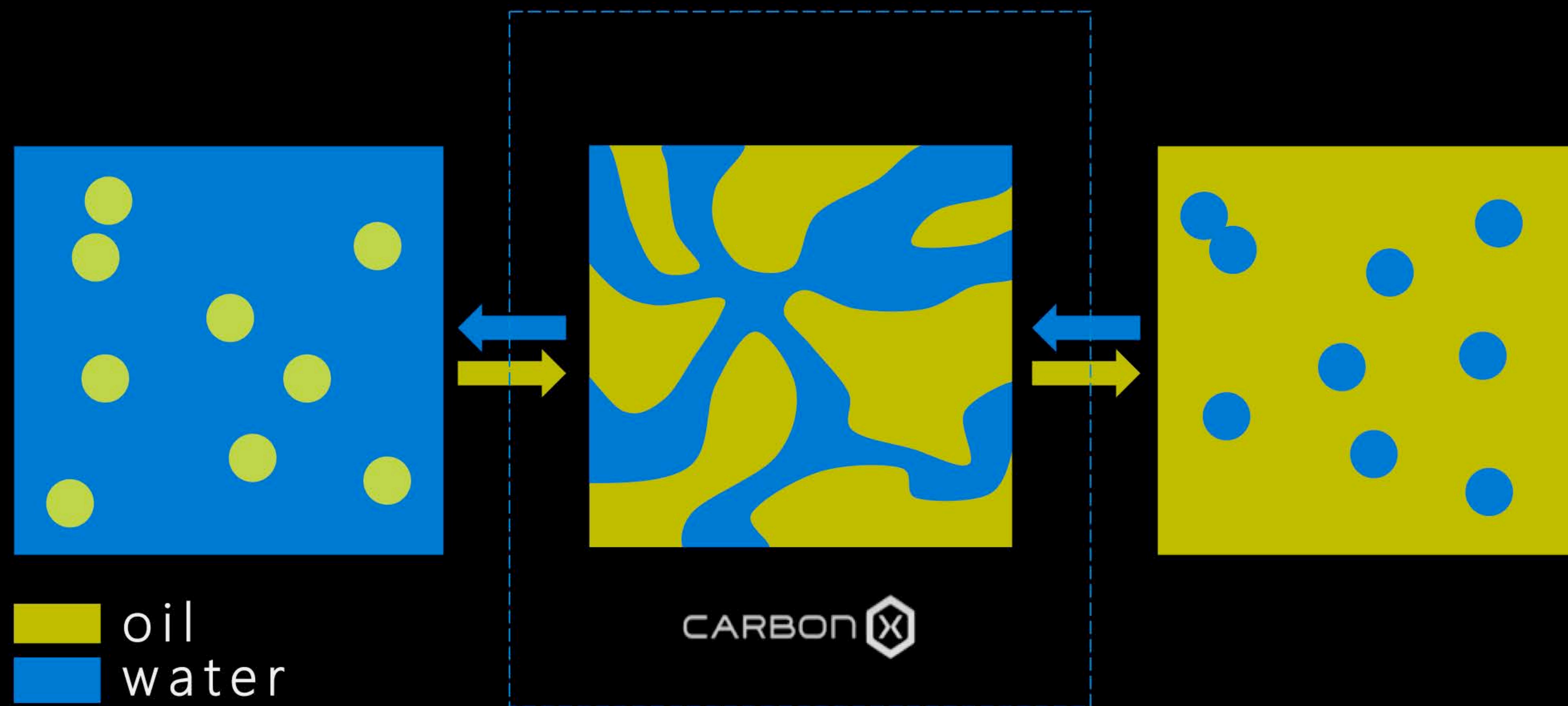
## Industry Leaders Keen to Test and Evaluate

- Top thermoplastic compounders (10+)
- EU leader in aerospace industry
- EU pipeline manufacturer for oil & gas industry
- 3D printing companies (10+)
- Global tire manufacturers (2 of top 5 players)
- EU leader in coatings and inks
- U.S. leader in battery industry
- Major Silicon Valley micro electronics company
- Japanese car manufacturer for hydrogen storage
- Filtering unit manufacturers and research institutions (3+)



# Commercial Scale Production

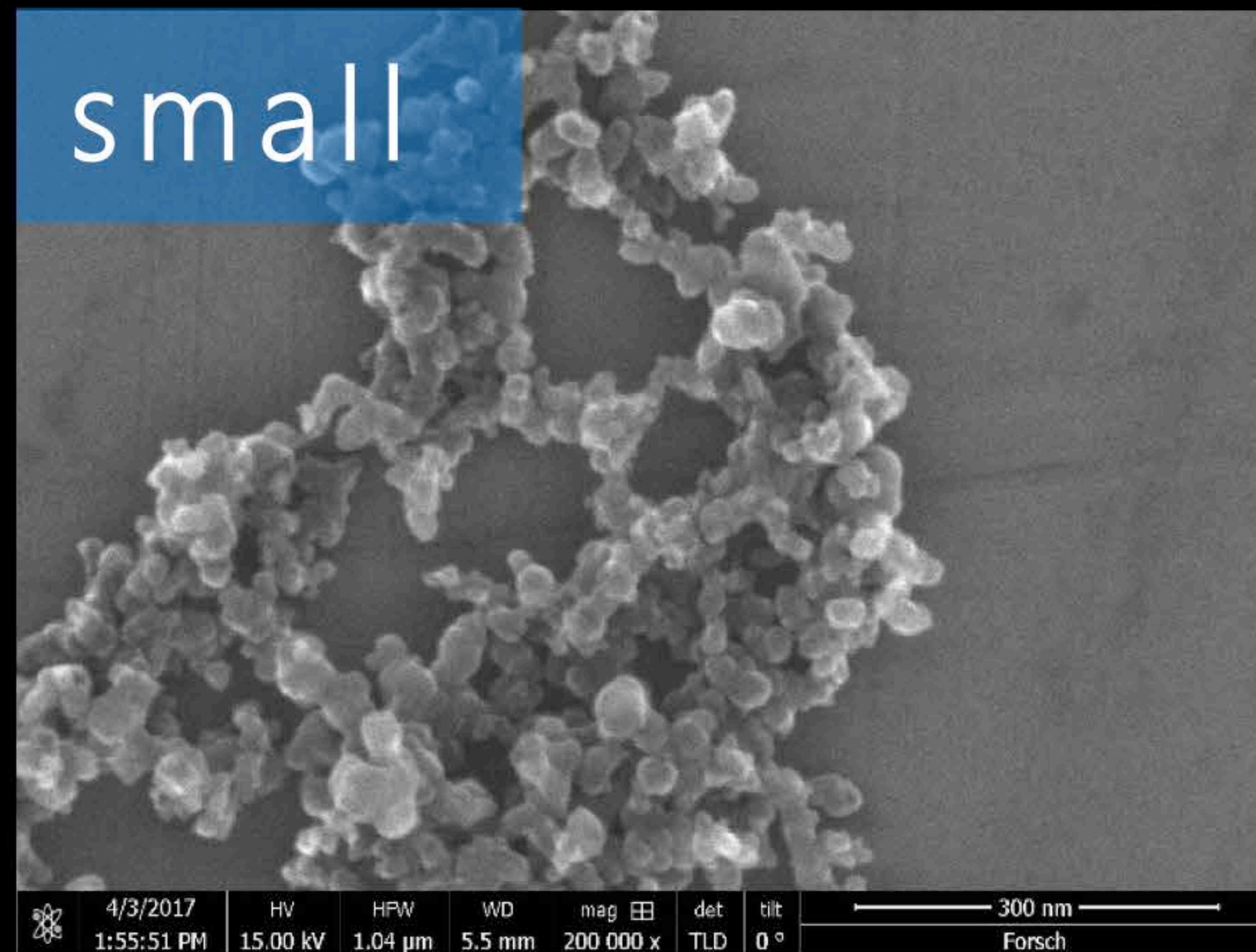
## Emulsion-based Catalysis in Carbon Black Plants



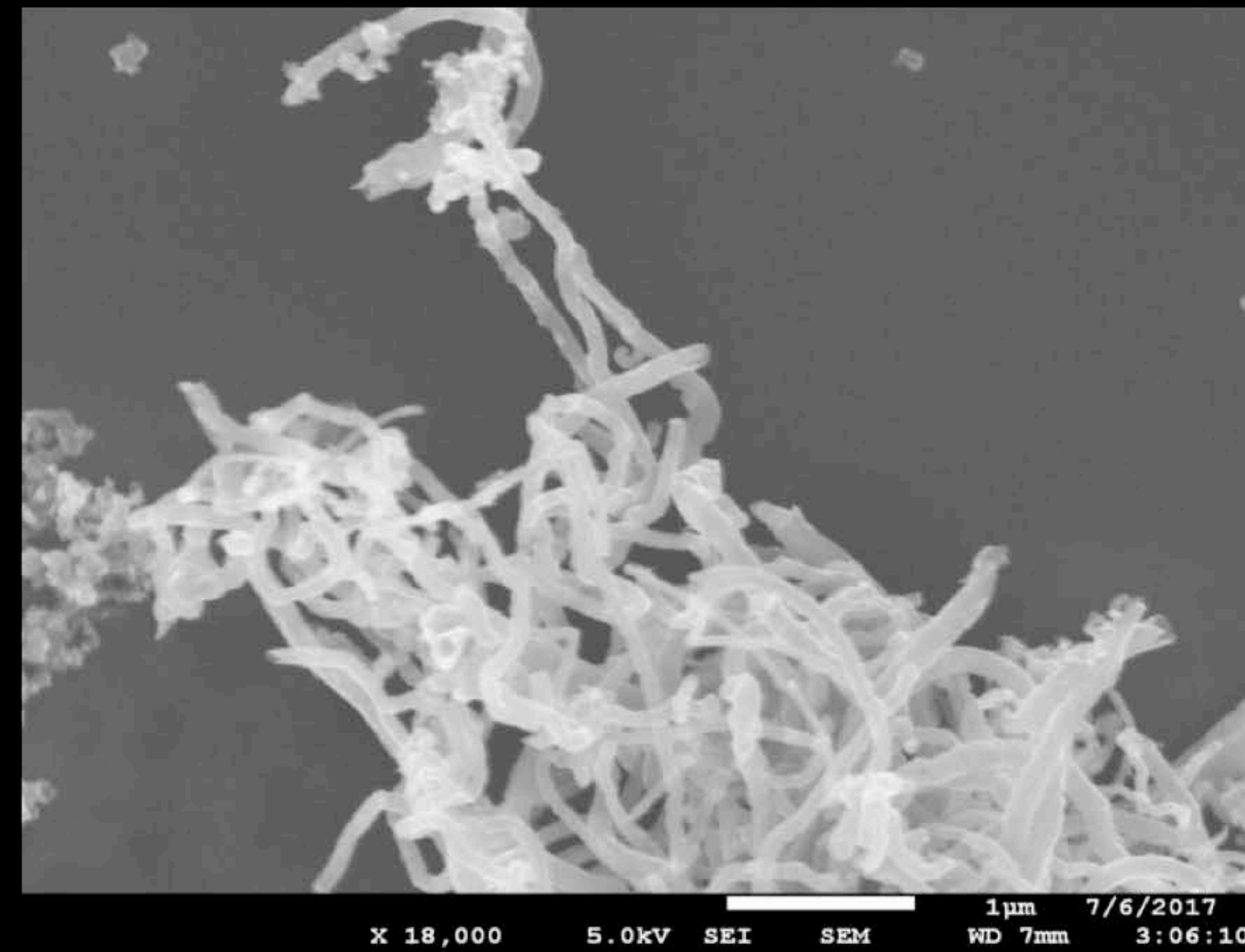


# Large Variety of Grades Possible

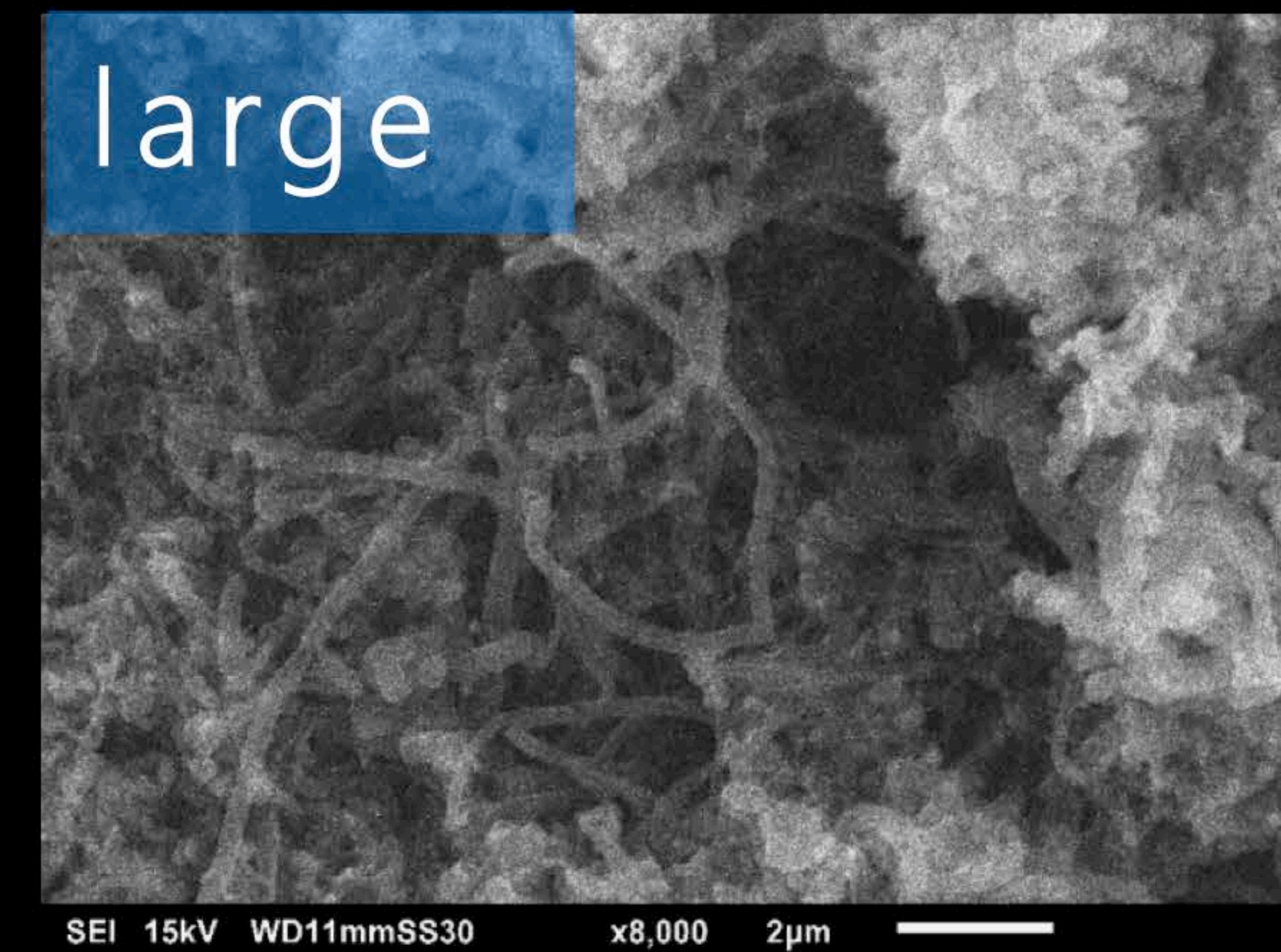
## Depending on Feedstock and Process Settings



$t_{\text{res}} = 10 - 100 \text{ ms}$   
 $d_F = 20 - 50 \text{ nm}$   
 $L_F = 2 - 3 \text{ d}$



$t_{\text{res}} = 100 \text{ ms} - 3,000 \text{ ms}$   
 $d_F = 50 - 100 \text{ nm}$   
 $L_F = 5 - 10 \text{ d}$



$t_{\text{res}} = \text{min} - \text{hours}$   
 $d_F = 100 - 300 \text{ nm}$   
 $L_F = 20 - 50 \text{ d}$

residence time ←  
fiber diameter ←  
fiber length ←



# Attractive Commercial Proposition

## Competitive Price with Mass Production

- Existing 15m MT production capacity in carbon black plants world-wide
- Replacing production of low margin carbon black, with sales price between US\$ 0.70 – 1.00 per kg
- Expected cost price CarbonX US\$ 1.20 – 1.50 per kg, sold at a substantial premium

### Sales Price (US\$)

Chopped glass fiber	1.50 - 2
Specialty carbon black	2 - 3
Activated carbon	2.50 - 3.50
Chopped carbon fibers	15 - 20
Highly conductive carbon black	18 - 20
Carbon nanotubes/fibers	> 100



# Key Priorities

## Complete Commercial Scale Production Trial

- Property and performance testing
- Sell and distribute for testing and evaluation
- Establish production partnerships
- Establish joint application development trajectories for key industry segments: automotive, aerospace, tires
- In parallel, develop applications with expected faster adoption time, such as ESD polymers, thin films, 3D printing filaments, etc.



# CarbonX – The Company

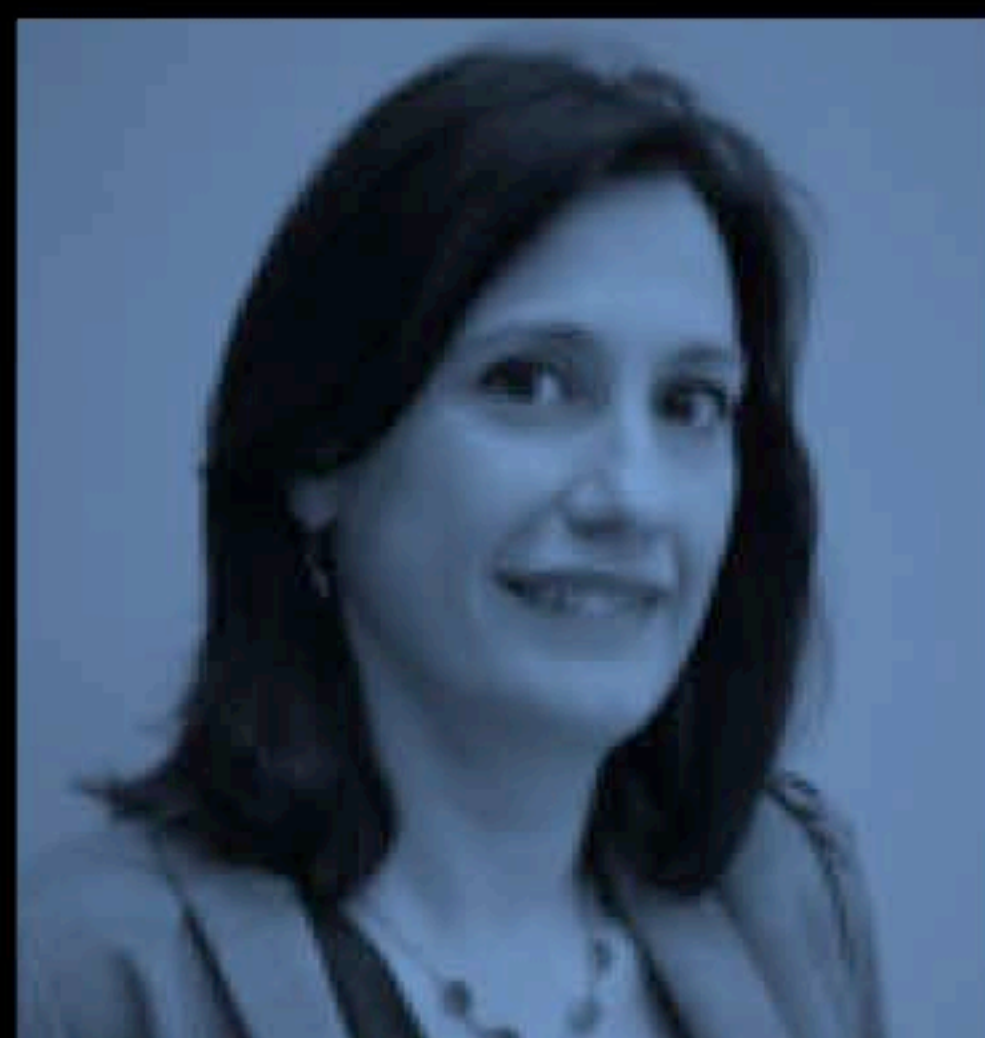
A Spin-off of Delft University of Technology

- Patented technology
- R&D center based in Delft
- Highly qualified team, consisting of 7 PhD/MSc in Chemistry & Engineering
- Focus on application development, product and performance testing, and low-cost mass production

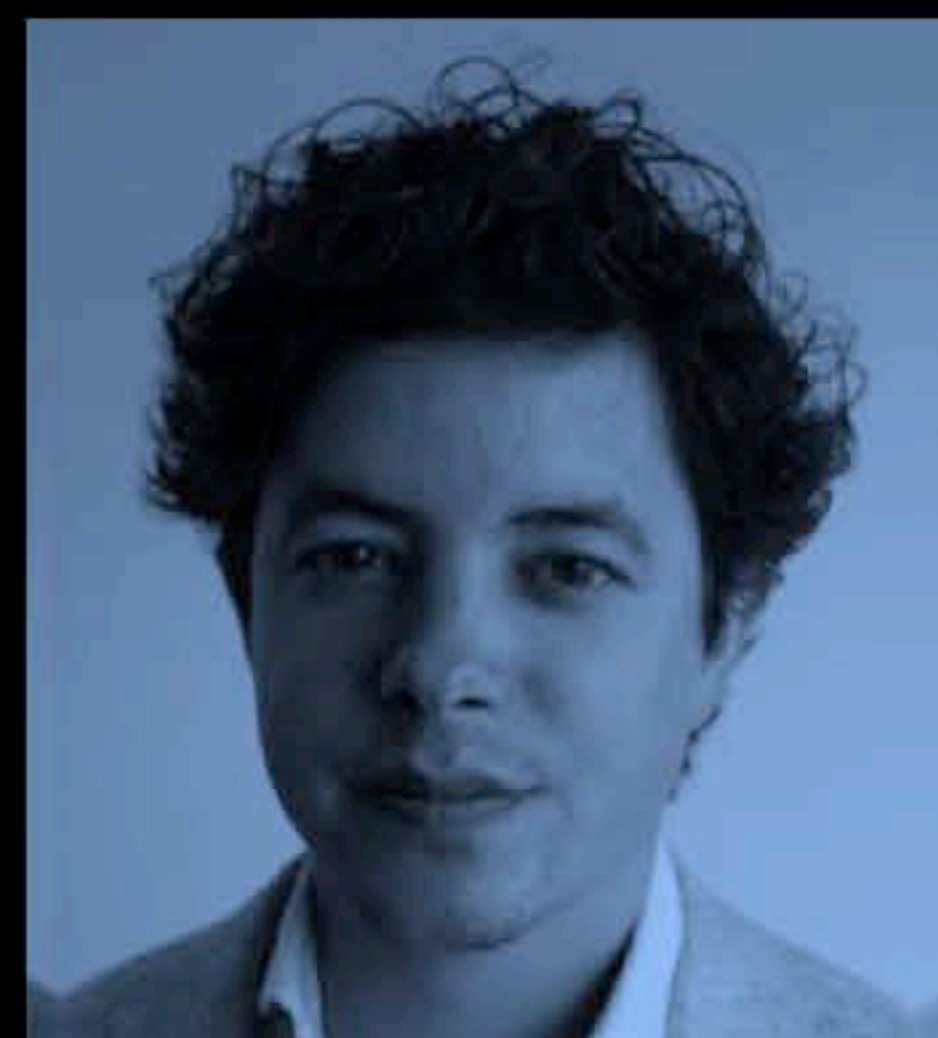


# Highly Entrepreneurial & Skilled Team

PhD or MSc degree in Chemistry & Engineering



**Daniela Sordi**  
Chief Technology Officer  
PhD Organic Chemistry



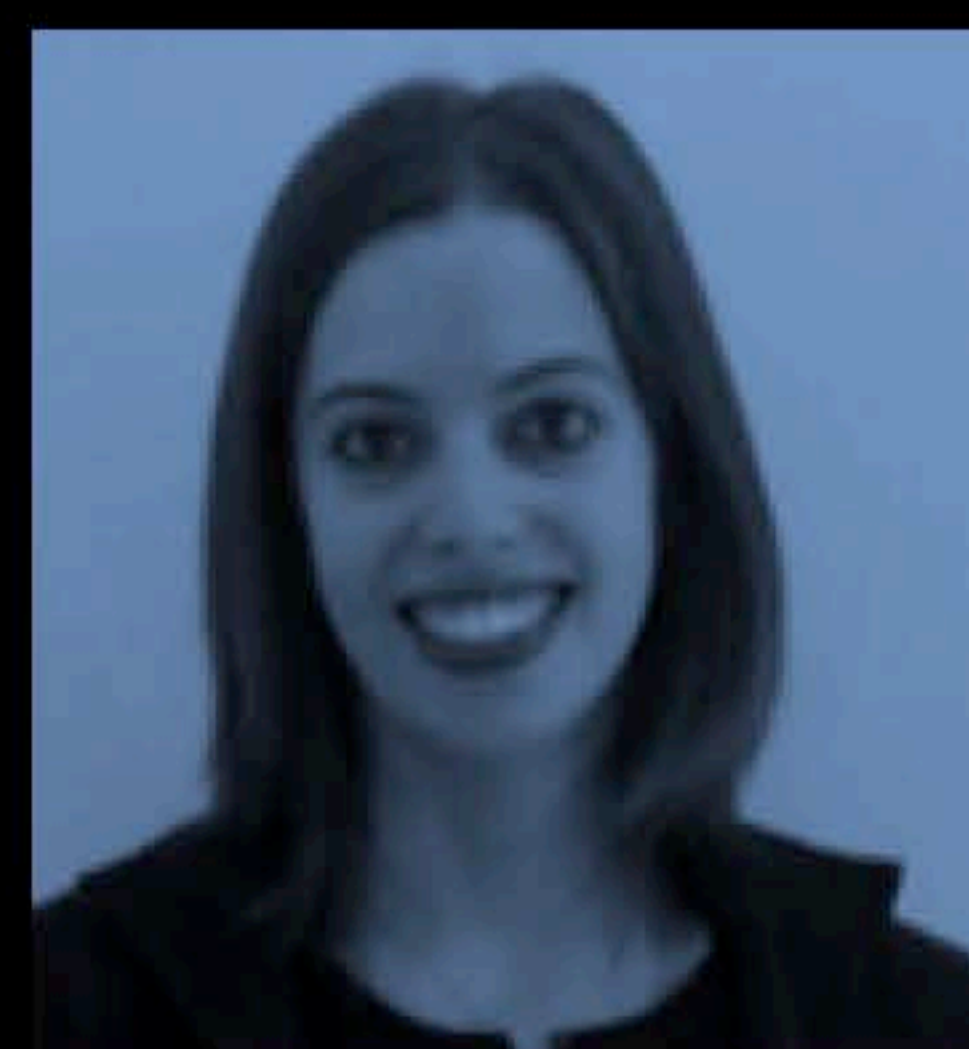
**Rutger van Raalten**  
Chief Executive Officer  
MSc Chemical Engineering



**Jeroen ten Dam**  
Head R&D  
PhD Heterogeneous Catalysis



**Emmanuel Skupien**  
Production Development  
PhD Heterogeneous Catalysis



**Laure Hannebicque**  
Quality Assurance & Control  
MSc Organic Chemistry



**Zhen Liu**  
Material Development  
PhD Polymer Science



**Luca Trotter**  
Innovation & Ecology  
MSc Industrial Ecology



# Intellectual Property

## Three Patents Protect CarbonX Technology

- IP1 (US2104248553)  
Emulsion-based catalytic system for CarbonX synthesis
- IP2 (US2013244023)  
CarbonX as a distinct synthetic carbon product
- IP3 (EP16176599)  
Production of CarbonX in thermal reactors

Freedom-to-operate opinion provided in 2014



# Investment Risks

Reduced after Product Performance Validation

- Product performance of commercial grades
- Long lead times for attractive sectors  
focus on early-adoption applications (ESD, thin films, etc.)
- Secure global production capacity  
highly consolidated in Europe, U.S., dynamic in China
- Ability to enforce patents
- Business/organizational challenges of scaling-up



