TrimTabs

Transforming Conductive Materials

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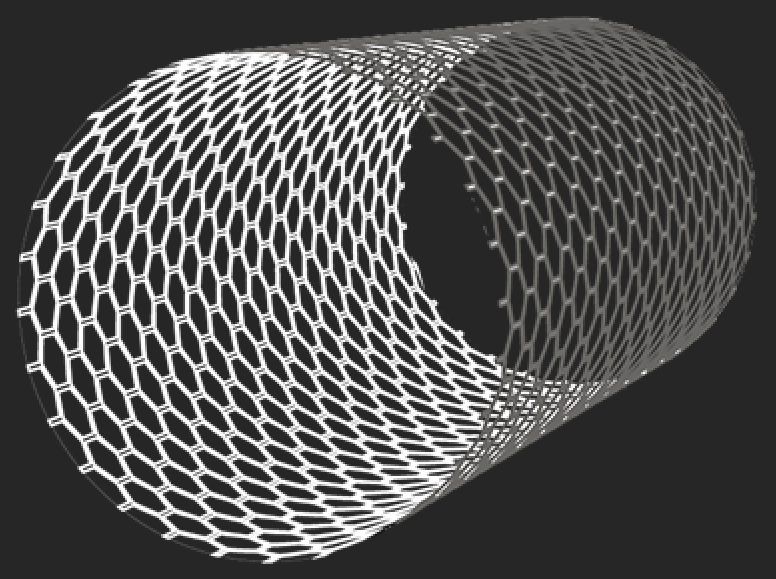
TrimTabs

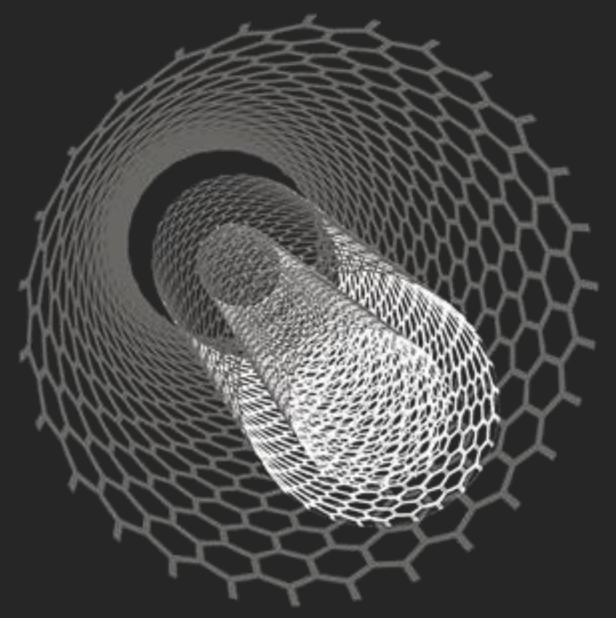
Trimtabs produces cost-efficient, high-performance carbon nanotubes at scale.

Our process is the product of 15+ years nanotube research from leading universities.

RICE UNIVERSITY | Massachusetts Institute of Technology | ESRI | Swansea University Prifysgol Abertawe



Single-walled carbon nanotube (SWCNT)



Multi-walled carbon nanotube (MWCNT)

Our Material Offerings

- **SWCNT**: Diameters from 0.8 – 1.2 nm.
- **MWCNT**: 60 minute dispersible in organic solvents: NMP, DMF, EtOH, and IPA.
- **CN-CNT**: carbon-nitride nanotubes offer greater stability, higher electron density, and longer battery lifetimes.
- **CNT Wires**: Patented CNT wires and demonstration Broadband data cable from Ostomy bags
- **“Iron Out”**: Simultaneously remove excess catalyst and amorphous carbon to ppm levels while increasing CNT purity.

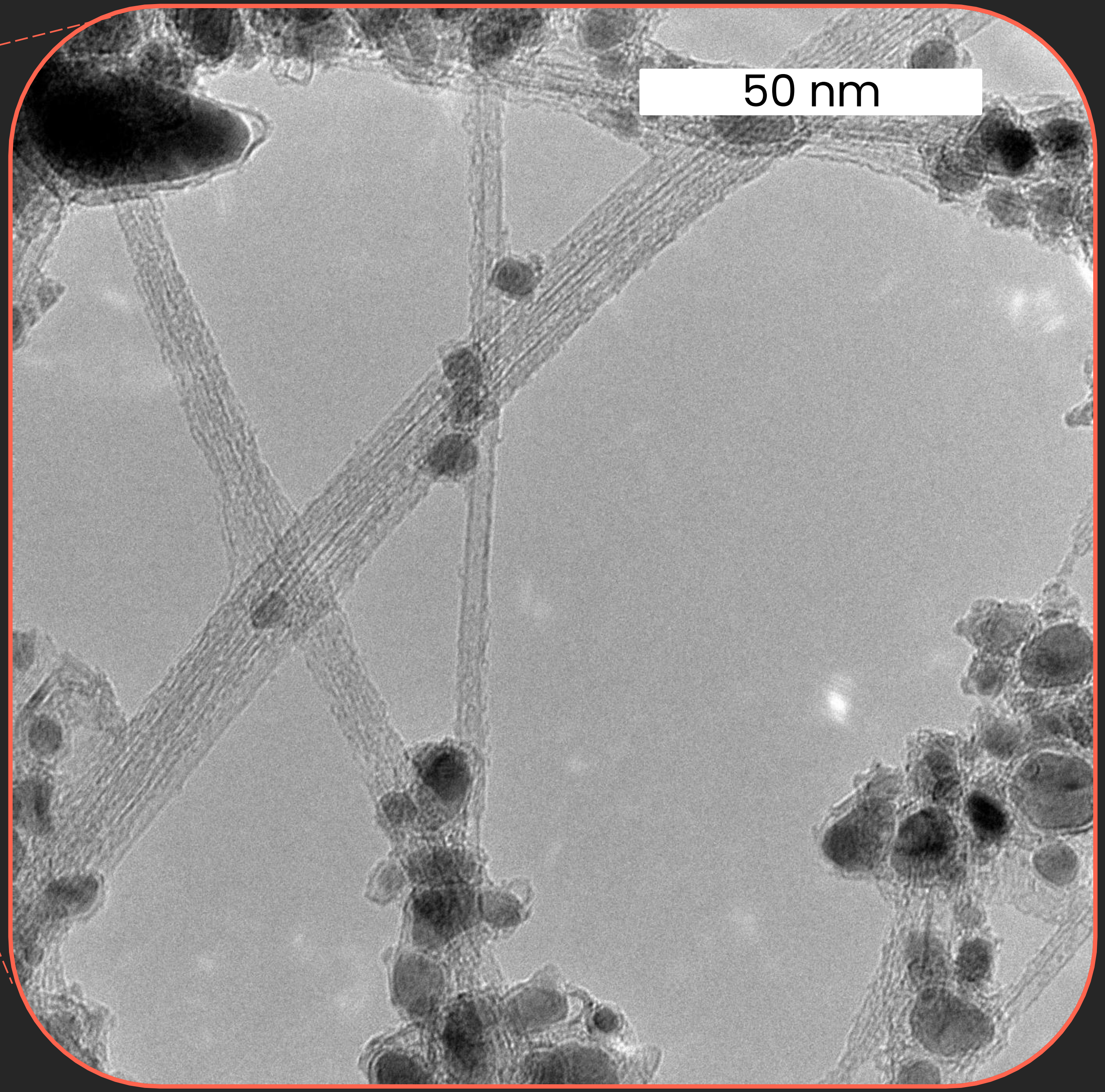
Single-walled nanotubes (SWCNTs)

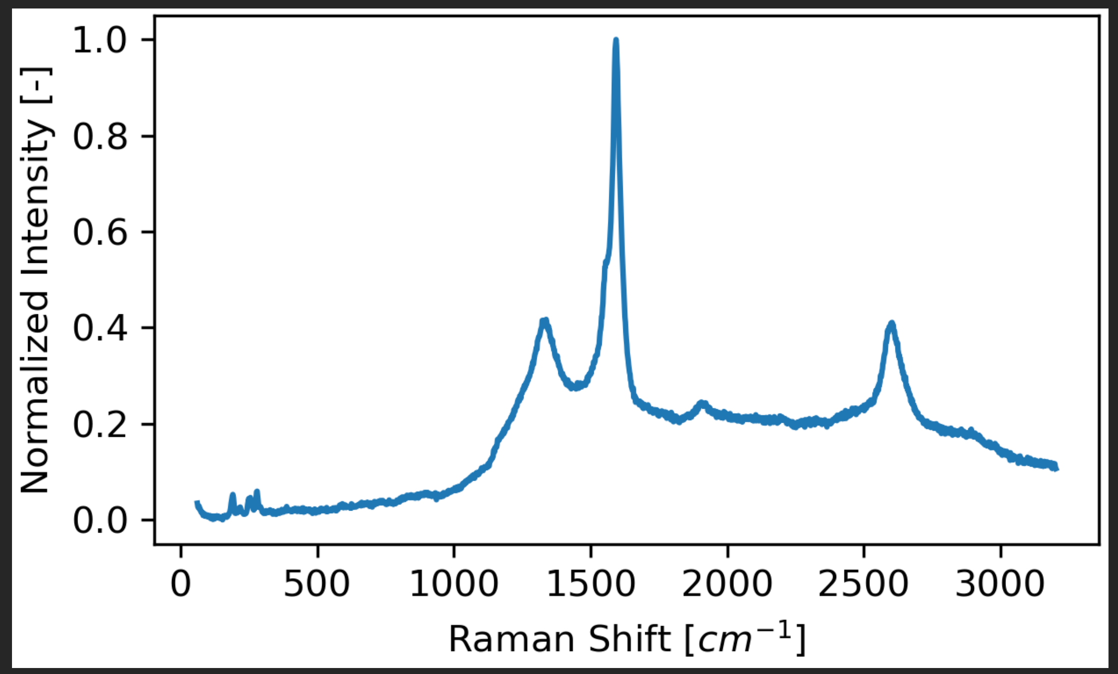
Features

- **Enhanced Conductivity and Support**: SWCNTs improve battery conductivity and mechanical stability, extending battery life in EVs and electronics.
- **Silicon Anode Stability**: They support silicon anodes, reducing volume expansion and enhancing battery cycle life and performance.
- **Better Dispersion**: SWCNTs ensure uniform electrode material distribution, boosting battery efficiency and consistency.
- **High-Performance Cathodes**: They enhance cathode materials' conductivity and thermal stability, vital for high-power lithium-ion batteries.
- **Supercapacitors and Hybrids**: SWCNTs increase energy density and rate capability in supercapacitors and hybrid energy storage, which is crucial for quick charge/discharge cycles.

SWCNT bulk material

SWCNT under TEM images





Raman spectroscopy revealed RBMs and G/D values > 5.

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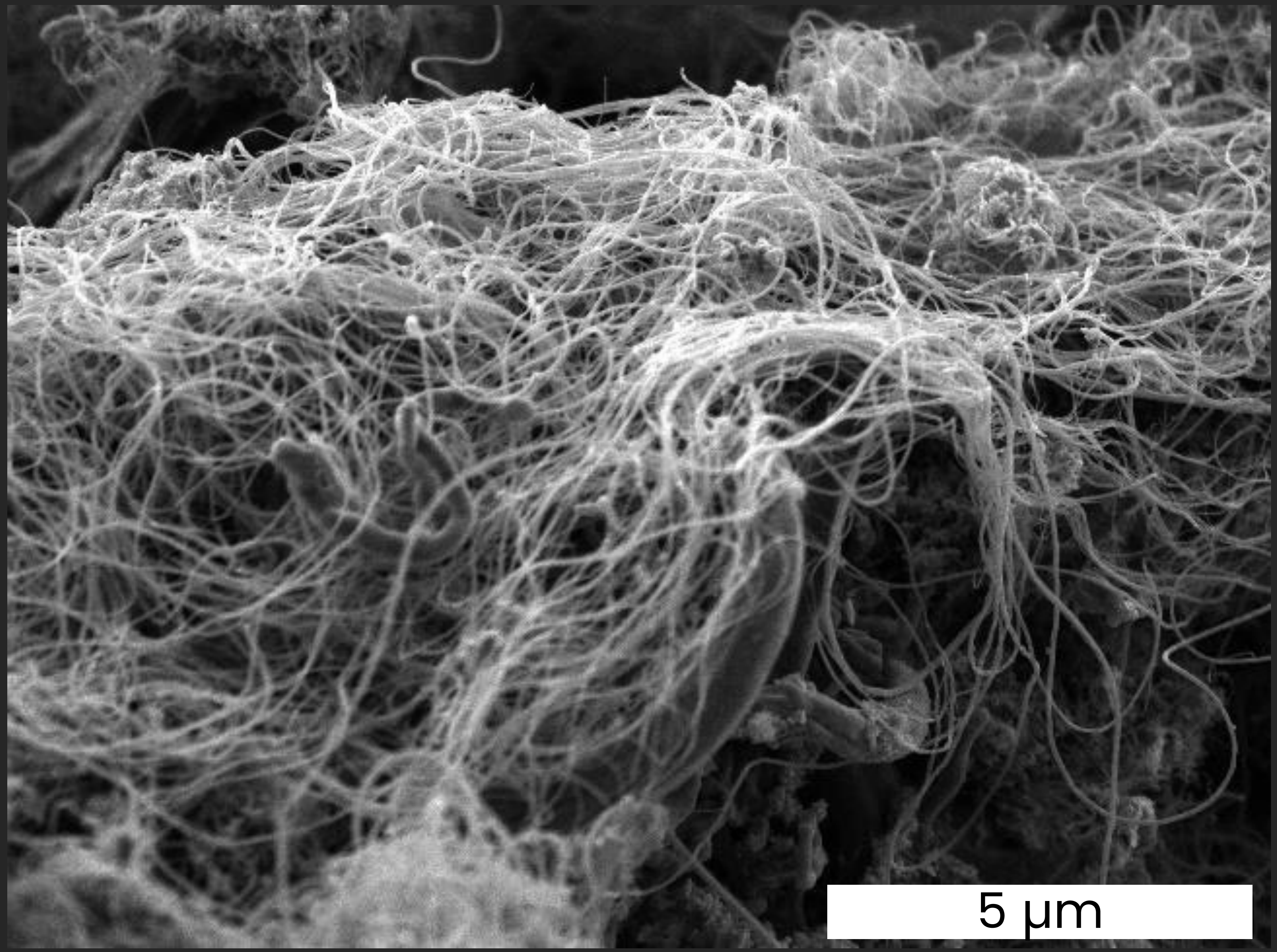
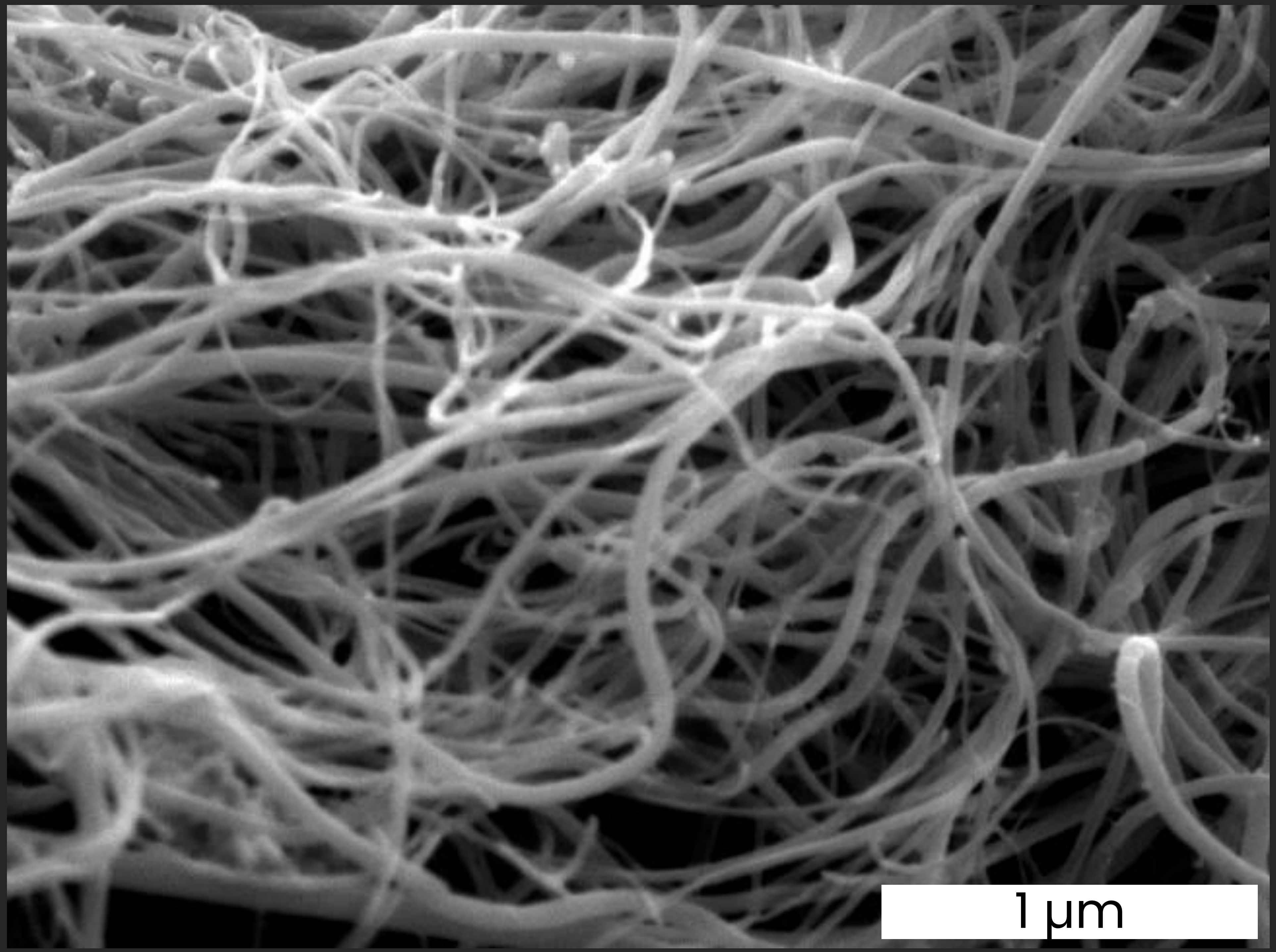
Multi-walled nanotubes (MWCNTs)



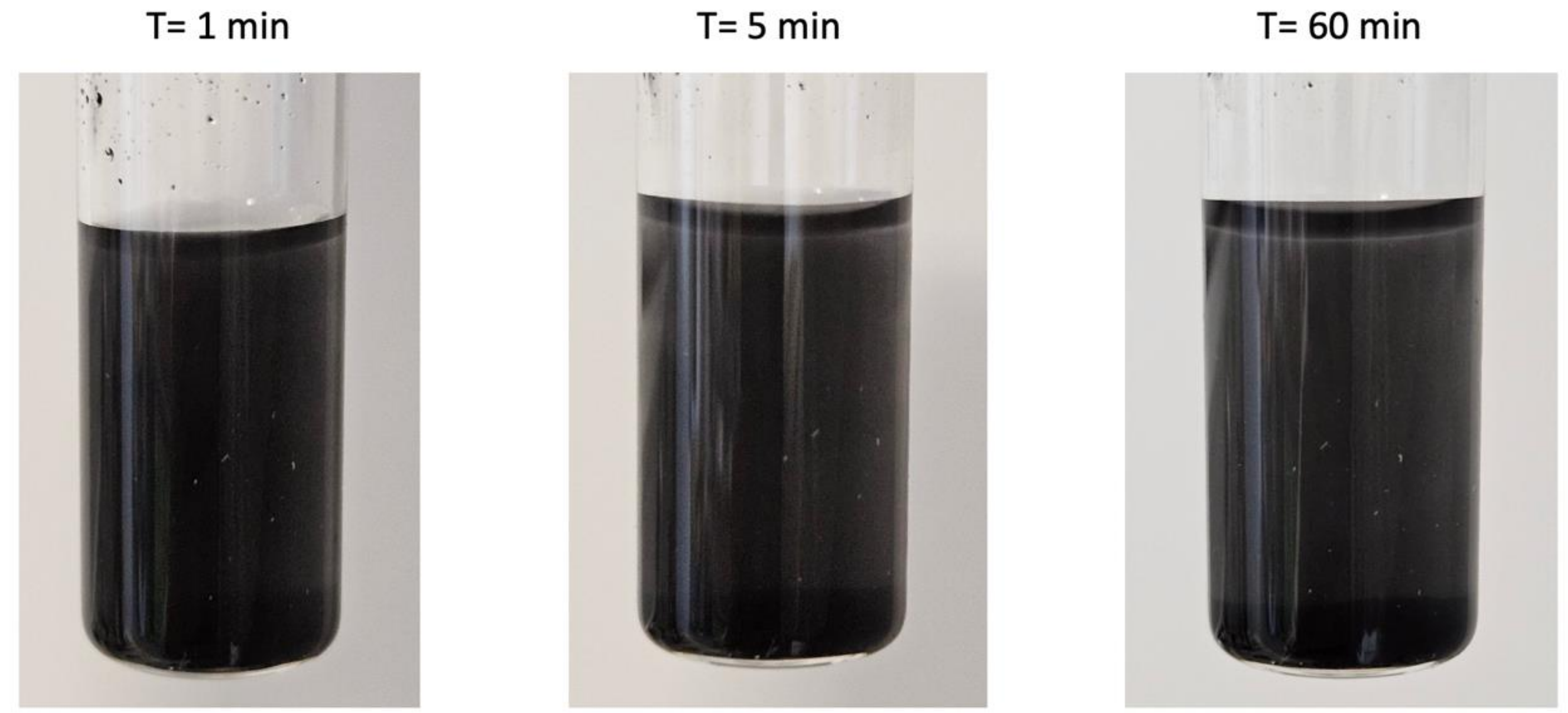


The average CNT diameter is 42 ±14 nm with uniform sample morphology, minimal amorphous carbon visible from SEM imaging

Our (MW) Nanotubes: Comparative Thermogravimetric Analysis

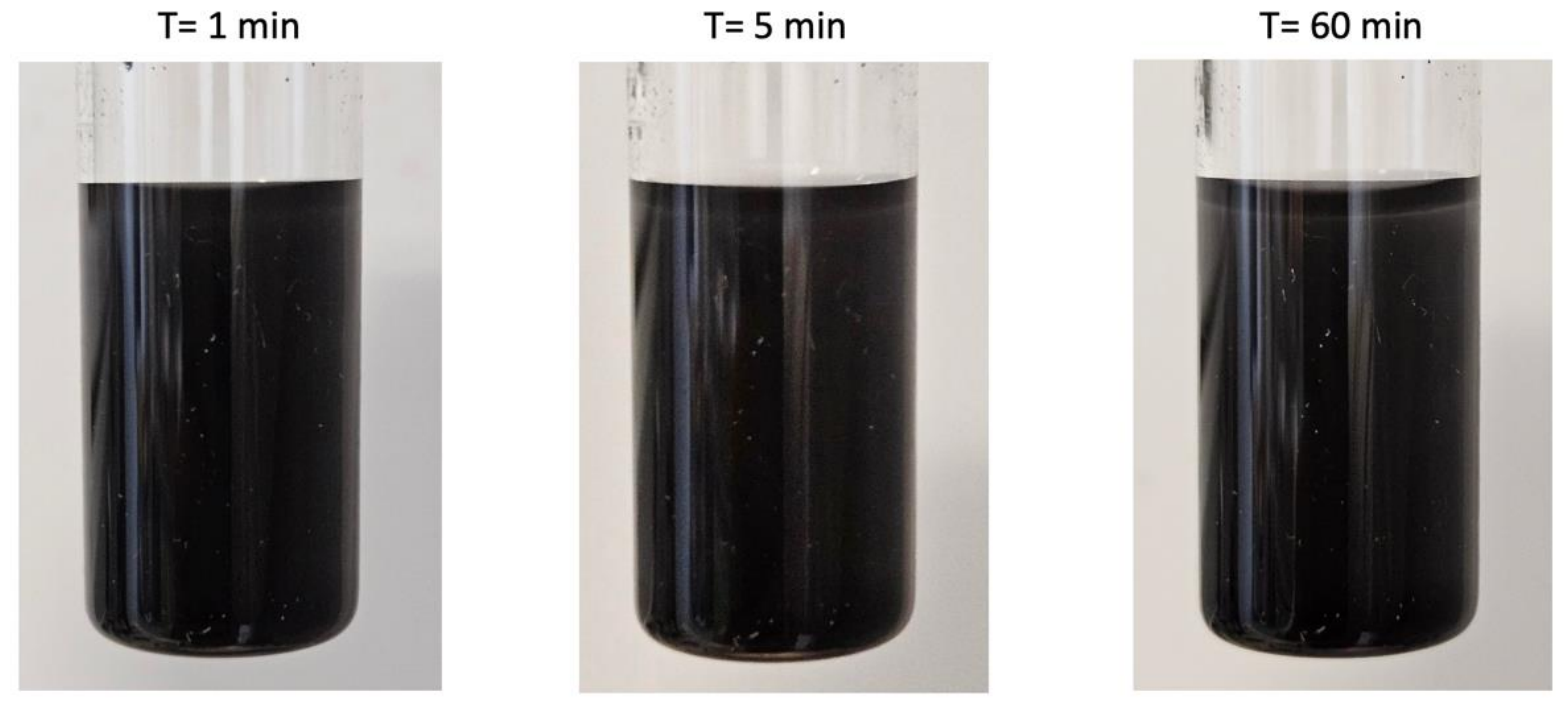
Sample	Description	CNT content (wt%)
Rice University HiPco SWCNT (HPR 195.3)	Industrial standard	75.64
Commercial HiPco	Industrial standard	17.91
TrimTabs	TrimTabs benchtop	91.4
TrimTabs (TTY23-08)	TrimTabs production	77.2
TrimTabs (TTY23-09)	TrimTabs production	86.0

Our MW Nanotubes: Solvent Dispersibility: Dimethyl formamide (DMF)



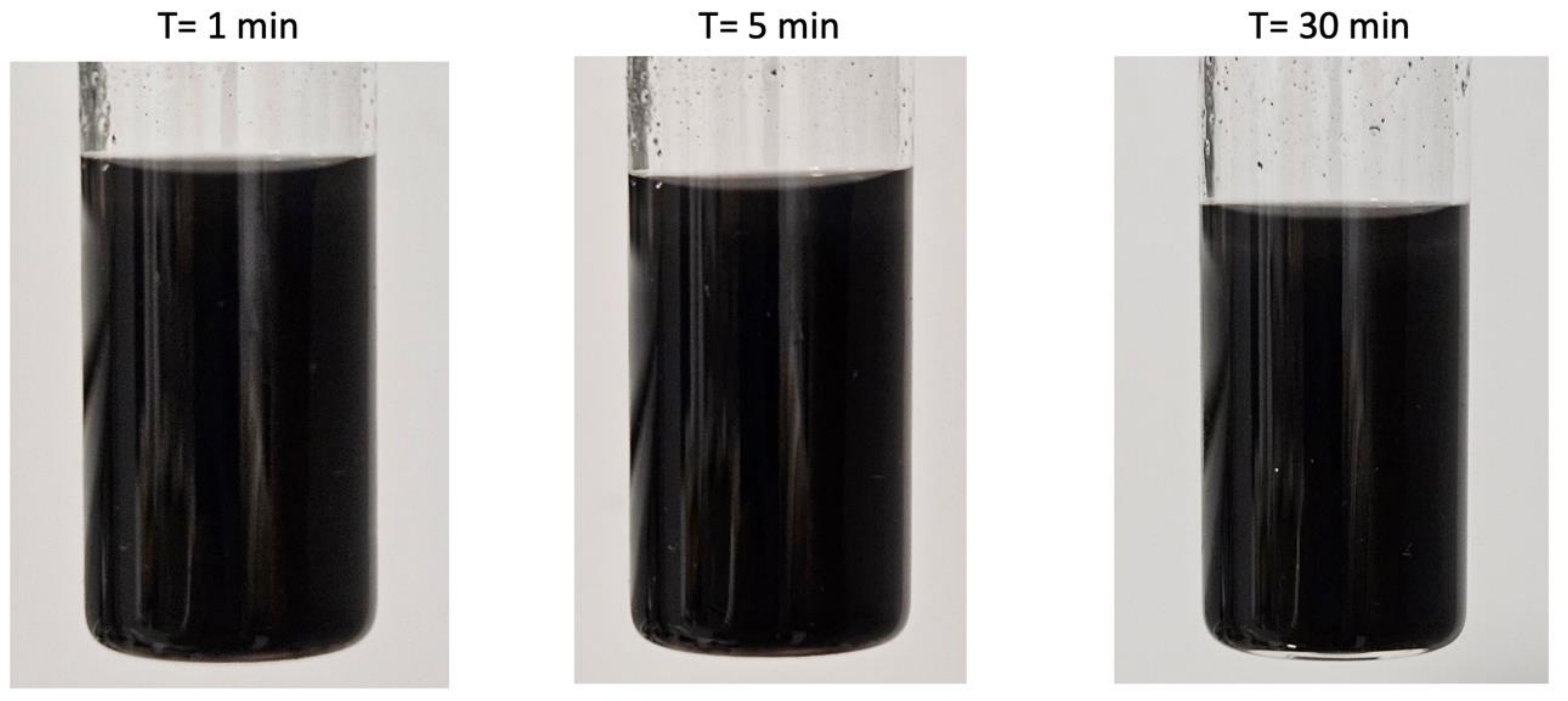
This sample disperses evenly within organic solvents such dimethyl formamide (DMF) 200 mg of TTY23-2208-08 was placed in a 10 mL scintillation vial and 5 mL of DMF was added inside. The dispersion was agitated using a vortexer for 30 seconds. Photos were taken at different time intervals beginning with t=0 min.

Our MW Nanotubes: Solvent Dispersibility: n-methyl pyrrolidone (NMP)



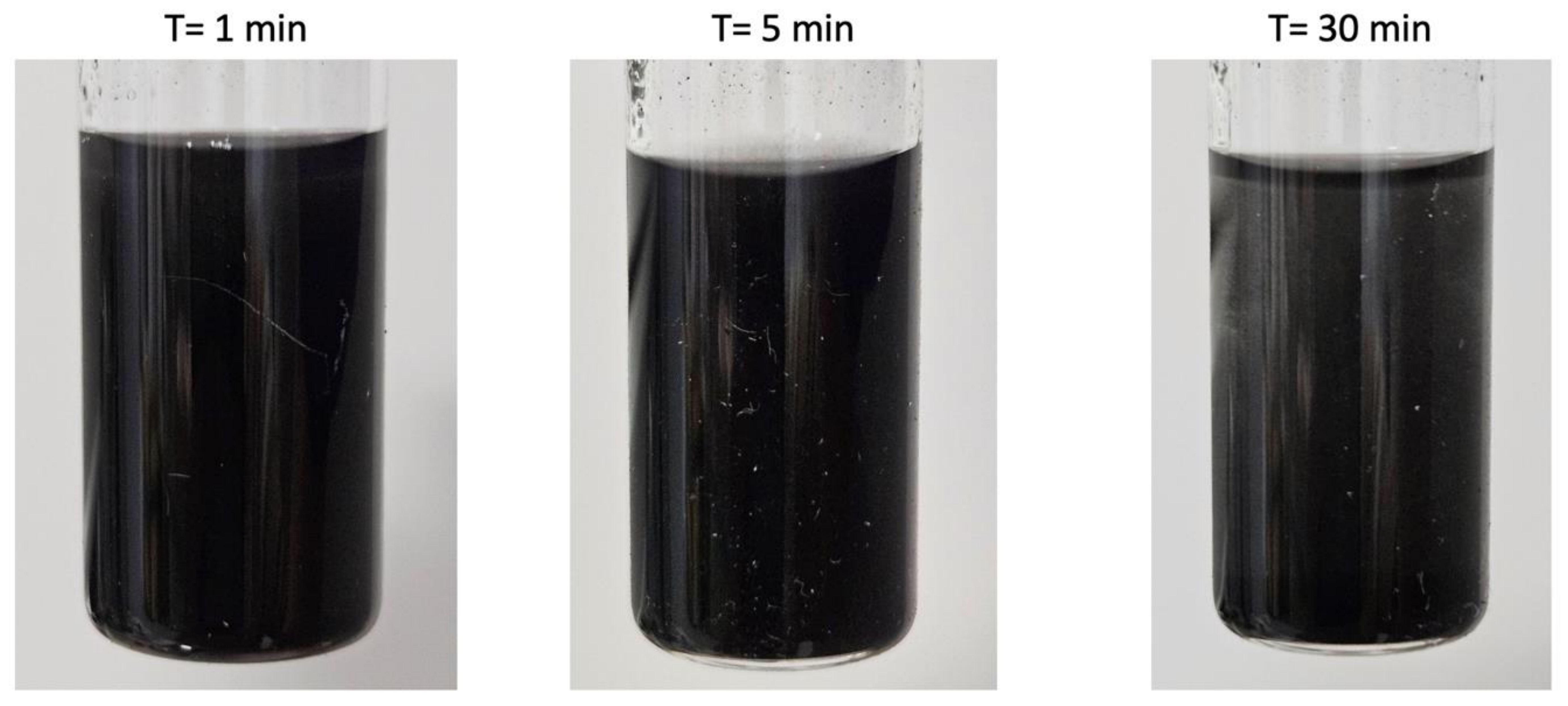
This sample disperses evenly within organic solvents such as n-methyl pyrrolidone (NMP). 200 mg of TTY23-2208-08 was placed in a 10 mL scintillation vial and 5 mL of NMP was added inside. The dispersion was agitated using a vortexer for 30 seconds. Photos were taken at different time intervals beginning with t=0 min

Our MW Nanotubes: Solvent Dispersibility in Ethanol



This sample disperses evenly within organic solvents such ethanol. 200 mg of TTY23-2208-08 was placed in a 10 mL scintillation vial and 5 mL of NMP was added inside. The dispersion was agitated using a vortexer for 30 seconds. Photos were taken at different time intervals beginning with t=0 min.

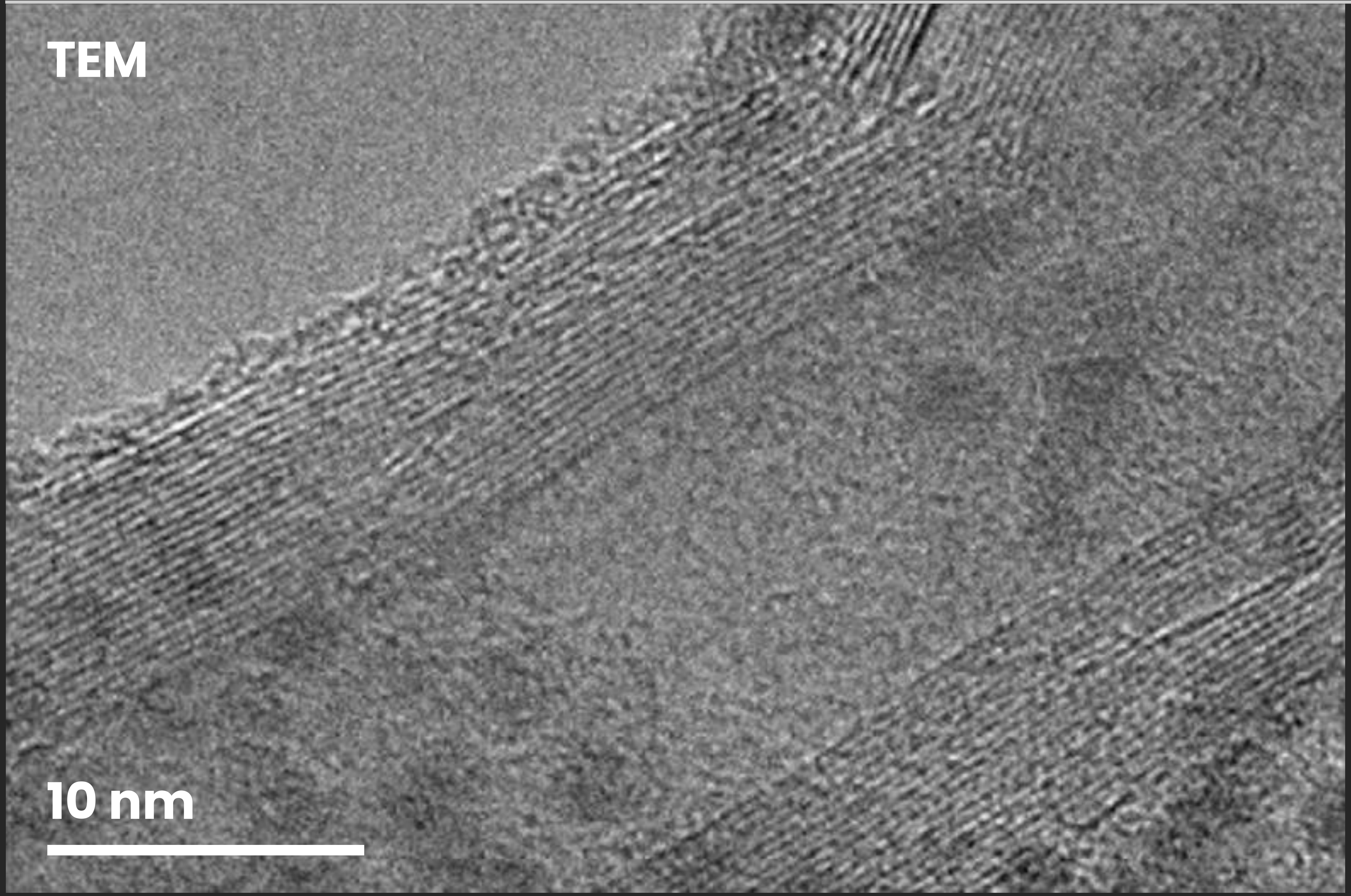
Our MW Nanotubes: Solvent Dispersibility in Isopropyl Alcohol



This sample disperses evenly within organic solvents such IPA. 200 mg of TTY23-2208-08 was placed in a 10 mL scintillation vial and 5 mL of IPA was added inside. The dispersion was agitated using a vortexer for 30 seconds. Photos were taken at different time intervals beginning with t=0 min.

External Validation Of Our Multi-Walled Carbon Nanotubes

Full report available upon demand



CHARACTERISTIC	TEST METHOD	VALUE
SP2 Bonded Carbon[b]	Raman	Detected
Number of Layers[a,*] (Wall)	TEM P10|P50|P90	9|15|31 Layers
Wall Dimensions[a,*] (Wall Thickness)	TEM P10|P50|P90	2.8|5.1|10.6 nm
Primary Particle Shape[a,b]	SEM, TEM	Nanotubes with spheroidal particulate material
Primary Particle Dimensions[a,b,*]	SEM P10|P50|P90	Length: 580|1107|2583 nm Diameter: 27|53|83.8 nm
Primary Particle Aspect Ratio[a,b,*]	SEM P10|P50|P90 (Length/Diameter)	13.7|22.3|39.4
Tapped Bulk Density[b]	WHO QAS/11.450 S.3.6 Method A	0.554 +/- 0.002 g/cm^3
Specific Surface Area[b]	BET (N_2 absorption after 200°C offgassing under high vacuum)	8.197 m^2/g
Chemical/Elemental Composition[b]	XPS	
Oxygen Content[b]	XPS	
C/O Ratio (by wt%)[b]	XPS	
Impurities[b]	XPS (Detection threshold: 0.1 at%)	

Material properties tested independently by ITA International Inc.

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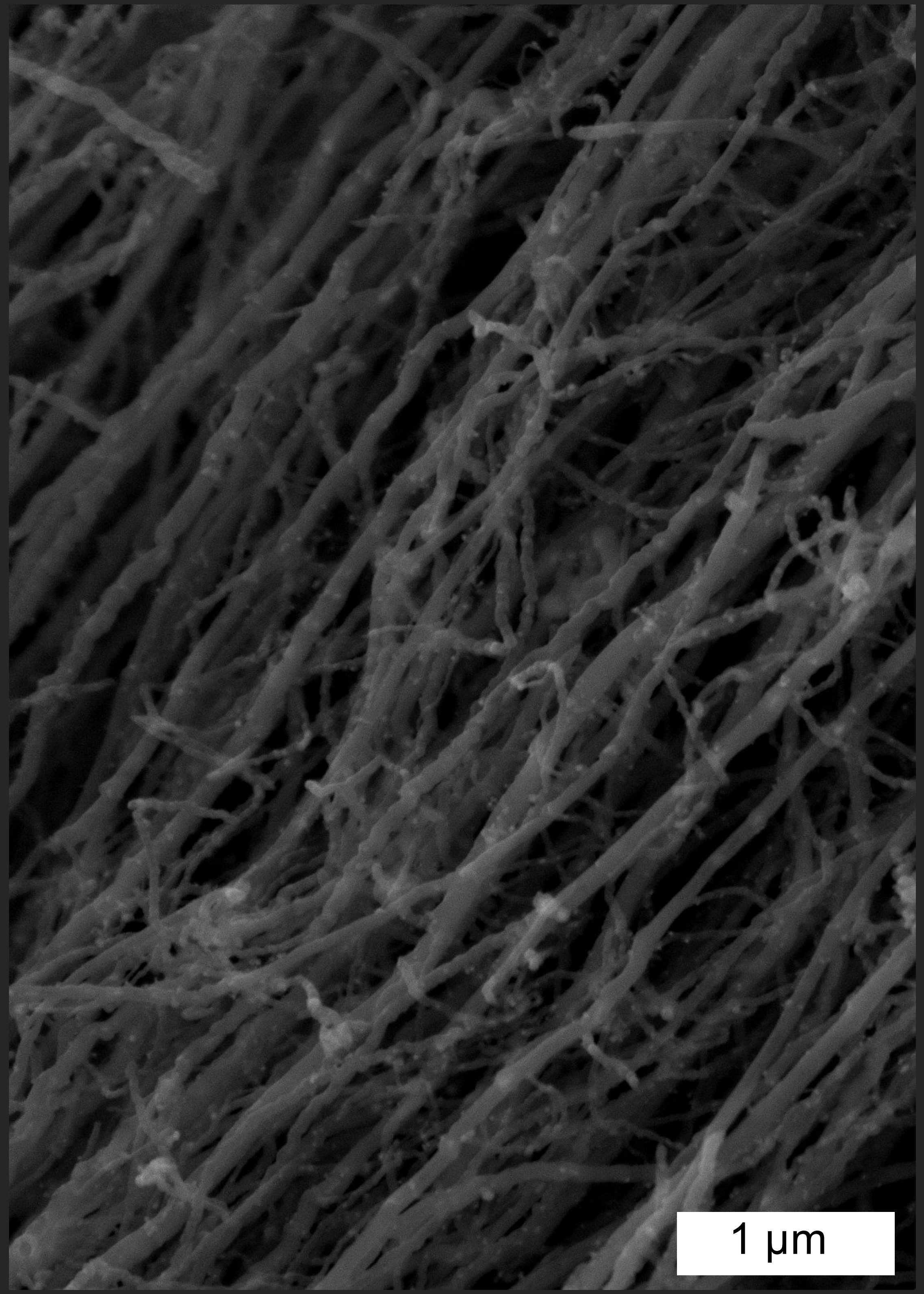
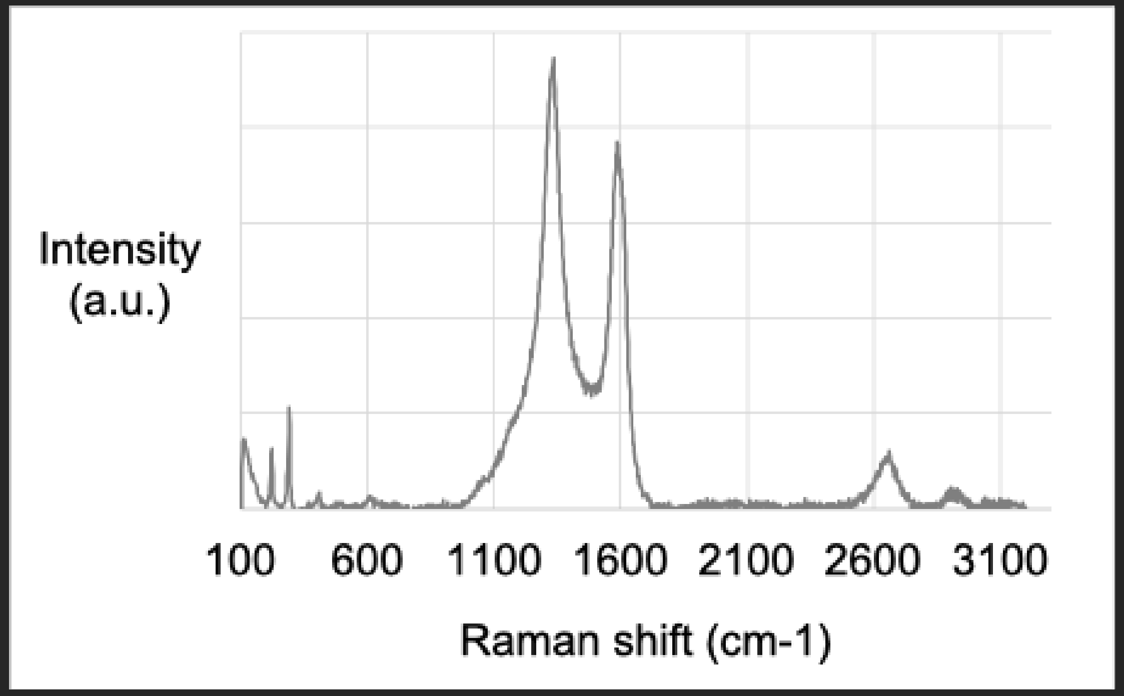
Nitrogen-doped Carbon Nanotubes (N-CNTs): both SW and MW (patent pending)

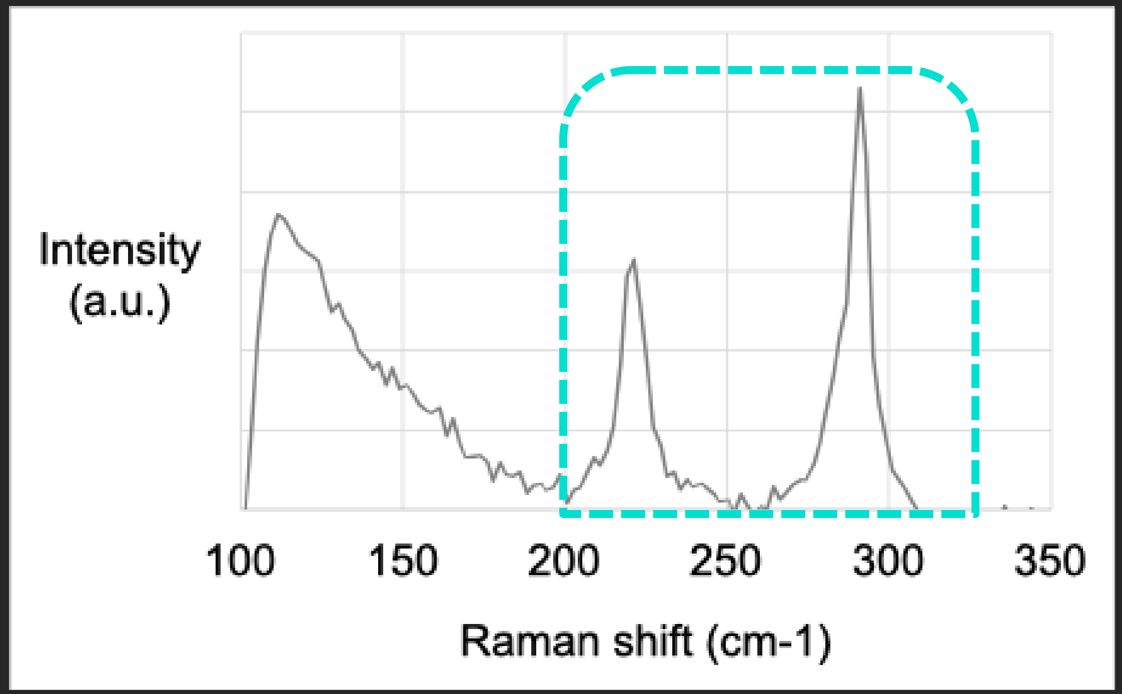
Features

- **Higher Specific Capacity**: CNNTs have greater specific capacity due to nitrogen doping, enhancing electrochemical performance for better energy storage and longer battery life.
- **Improved Stability**: CNNTs offer superior chemical and thermal stability, ensuring better cycle stability and longevity and maintaining capacity over many charge-discharge cycles.
- **Better Conductivity**: The unique structure of CNNTs, with increased surface area and porosity, improves conductivity and ion transport, enabling efficient charging and discharging.
- **Enhanced Efficiency**: CNNTs have higher surface area and porosity, boosting interaction with materials and efficiency in catalysis and energy storage applications.
- **Durability**: Nitrogen in CNNTs increases chemical and thermal stability, making them more durable and reliable for long-term use in harsh environments.



Representative scanning electron images of CNNTs

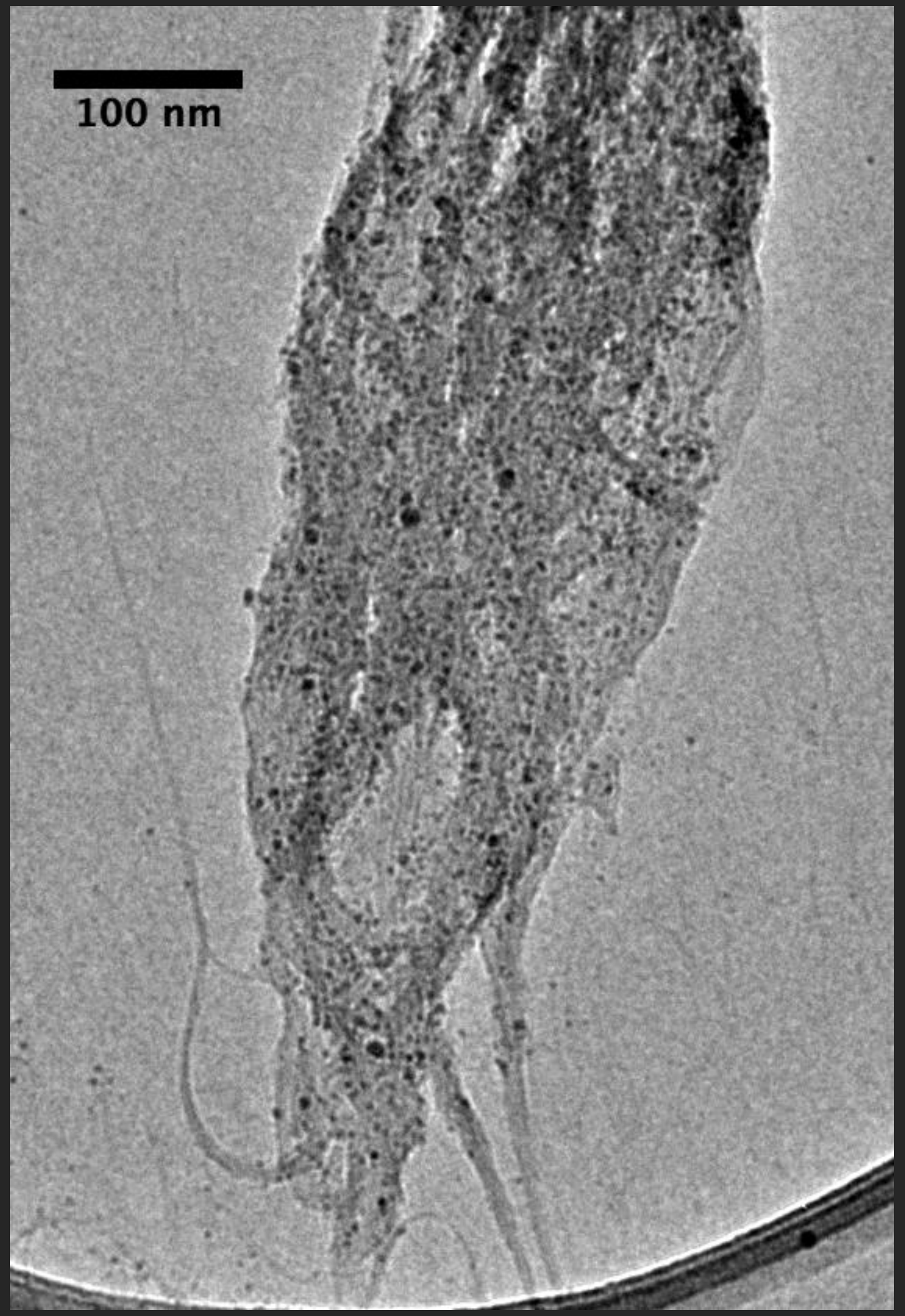




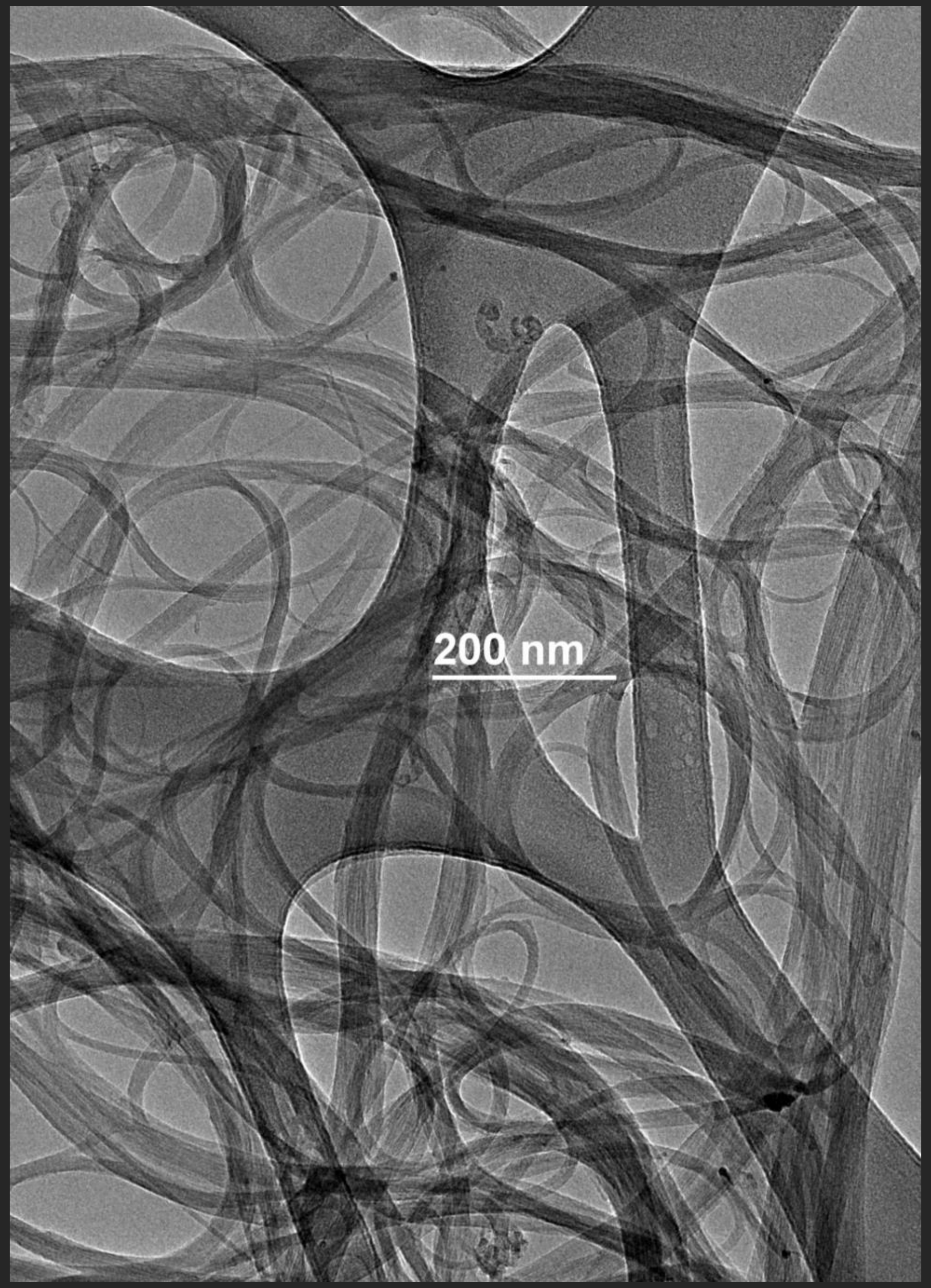
Spectra of CNNTs having presence of single walled NTs by dotted lines over the radial breathing modes (RBMs).

Iron Out (patent pending)

Before Cleaning

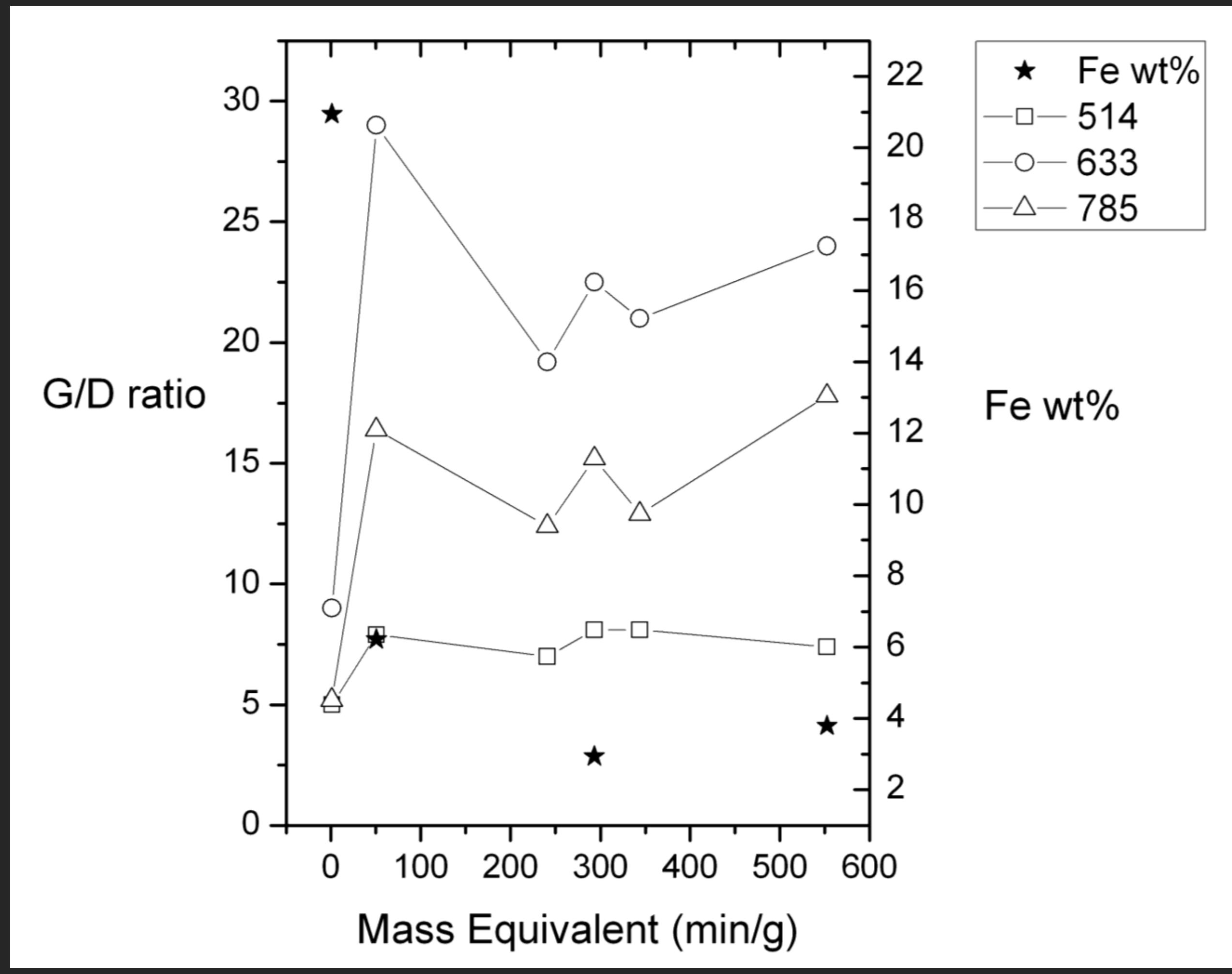


After Cleaning



Post-treatment, catalyst particles are almost entirely absent, demonstrating the high efficiency of the patented Iron Out method in purifying the nanotubes.

Representative Data



Thermogravimetric and Raman data on the removal of iron from carbon nanotubes.
Sub-ppm levels of Iron have been achieved but cannot be measured using thermogravimetric analysis.

Features

- **Enhanced Electrical Conductivity**: Removing iron and other metallic impurities from CNTs significantly enhances their electrical conductivity.
- **Improved Battery Performance**: By reducing iron content to less than 1 wt%, the "iron out" process ensures more stable and efficient battery performance, leading to better energy storage and faster charging times.
- **Increased Material Compatibility**: The purification process ensures better composite material formation, enhancing the mechanical strength and durability of batteries.
- **Scalability and Automation**: The process is designed for high-throughput manufacturing and can be automated.
- **Water Dispersibility**: Process refinements enhance the water dispersibility of CNTs.

Circular Economy

Upcycling Ostomy Bags to Electrical Wires

TrimTabs partnered with Salts Healthcare, a healthcare equipment provider to reprocess some of its excess equipment, made of plastic.

https://www.youtube.com/watch?v=miyAtKlllk

The Result:

Using our patented technology we turned the plastic into high performance cat 5 cable, able to transmit data at speeds>100mbps.

1. On the Use of Carbon Cables from Plastic Solvent Combinations of Polystyrene and Toluene in Carbon Nanotube Synthesis. *Nanomaterials* **2022**, *12*, 9. https://doi.org/10.3390/nano12010009
2. From Waste Plastics to Carbon Nanotube Audio Cables. *C* **2022**, *8*, 9. https://doi.org/10.3390/c8010009
3. Upcycling of Face Masks to Application-rich Multi- and Single-walled Carbon Nanotubes. Carbon Letters 2022 https://doi.org/10.1007/s42823-022-00398-8

TrimTabs

Solids

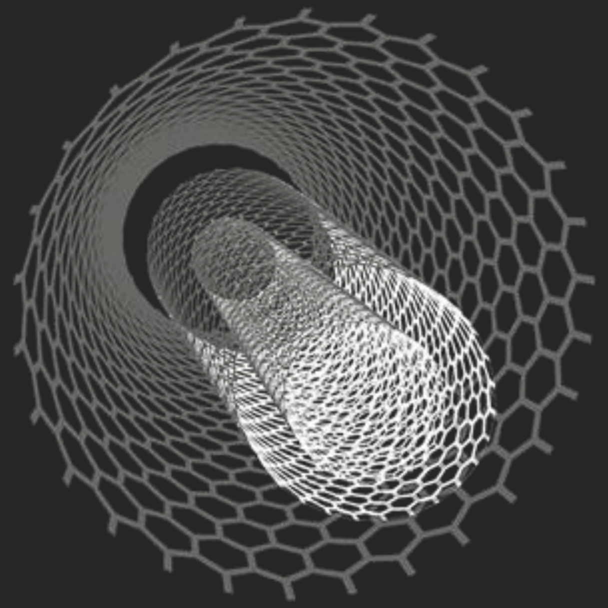
Face masks
Lycra
Elastene
Polyester
Polystyrene
Polyurethane
PVdC films
Hydrocolloids
Isotactic polypropylene
Polyethylene terephthalate
.... to name a few

Liquids

toluene
benzene
M-cresol
cyclohexane
cyclopentane
methylcyclopentane
Hexafluoroisopropanol
... to name a few

Value Materials

- Carbon nanotubes
- Carbon nanofibers
- Carbon fibres
- Synthetic Graphite
- Graphene
- Hydrogen



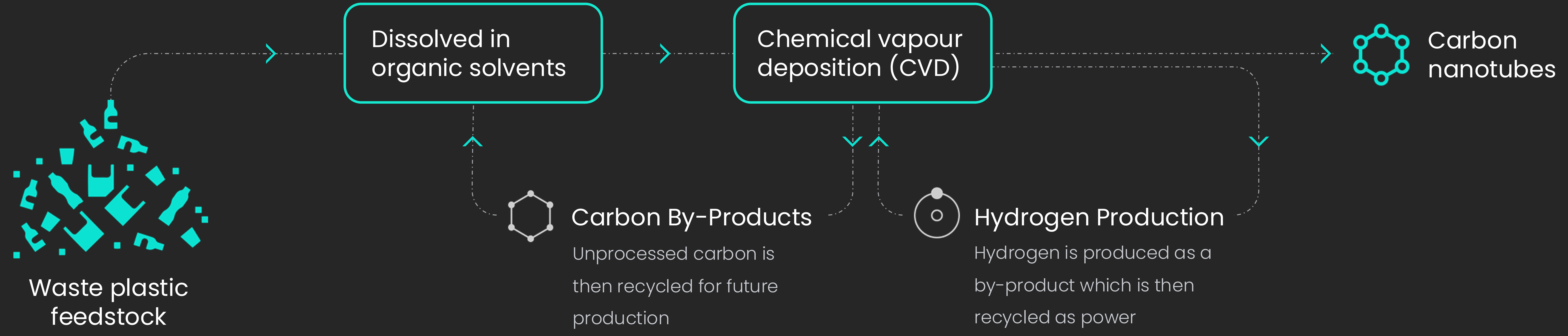
CNTs

Hydrogen

Properties

- Conductive
- Lightweight
- High strength
- Non-flammable
- Carbon sink

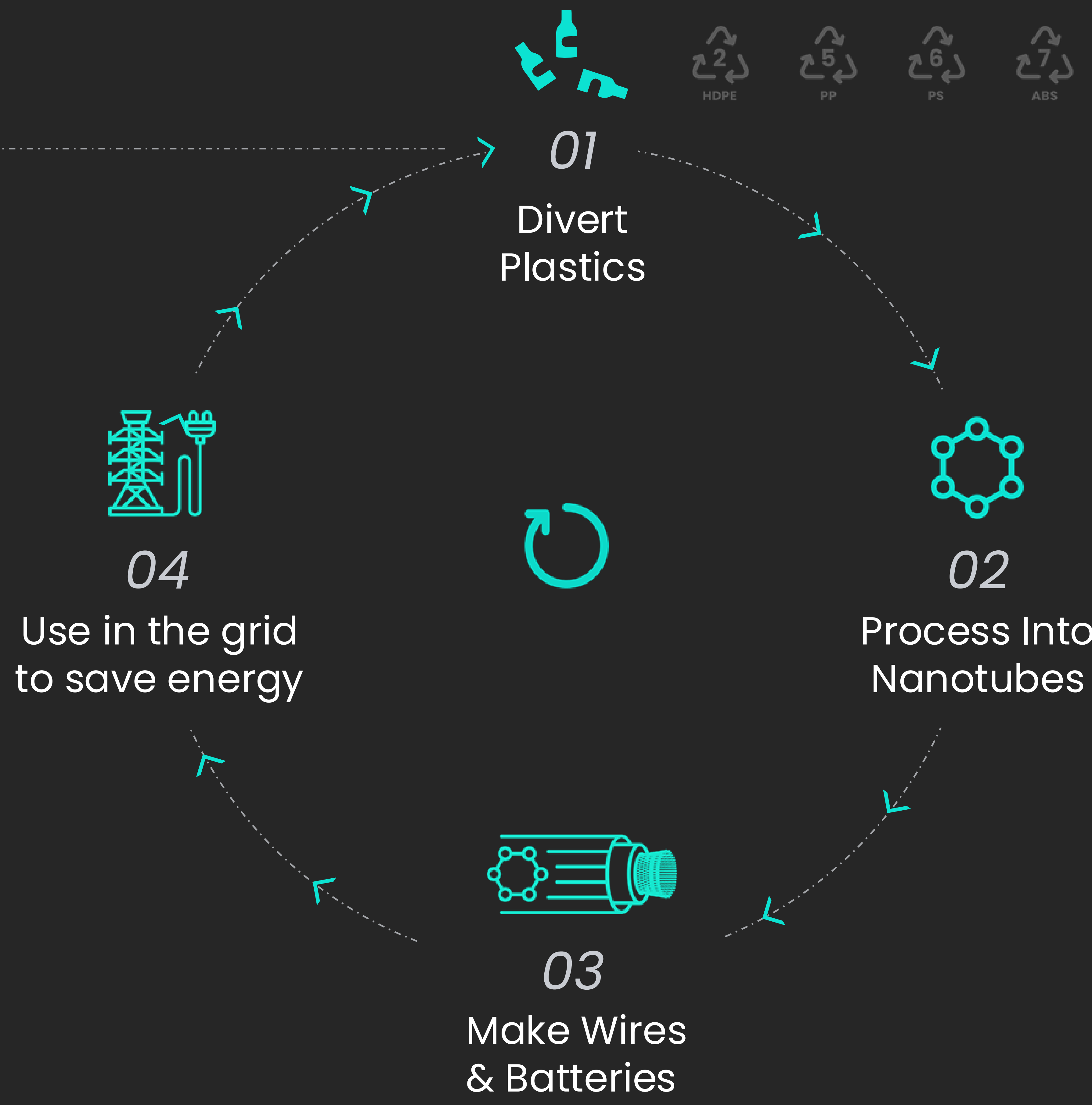
Our patented process **transforms waste plastic** into high-quality and differentiated nanotubes.



Our process is modular, scalable and fast: Using off the shelf equipment, we can bring new production sites online in <6 months.

Impact: A Circular Future

- **250 kg** of plastic into **£250k** of product
- **60 MT/Year** of CO_2 saved by gas recirculation
- **2000 TpA** plastic diverted when all EV batteries use TrimTabs CNTs
- **0.7 GT/Year** CO_2 by reduced emissions using EVs
- **32 MT/Year** CO_2 saved if every 737 used our wires
- **1 Bn liters/year** water saved using TrimTabs



A Circular Future

Our process allows the recycling of plastic and solvent waste into highly efficient materials that underpin a transition to clean energy.

We provide plastic and solvent upcycling; we are able to remove carbon from waste and help companies transition to a circular process.

“Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we've been ignorant of their value.”

R. Buckminster Fuller

Thank You

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