



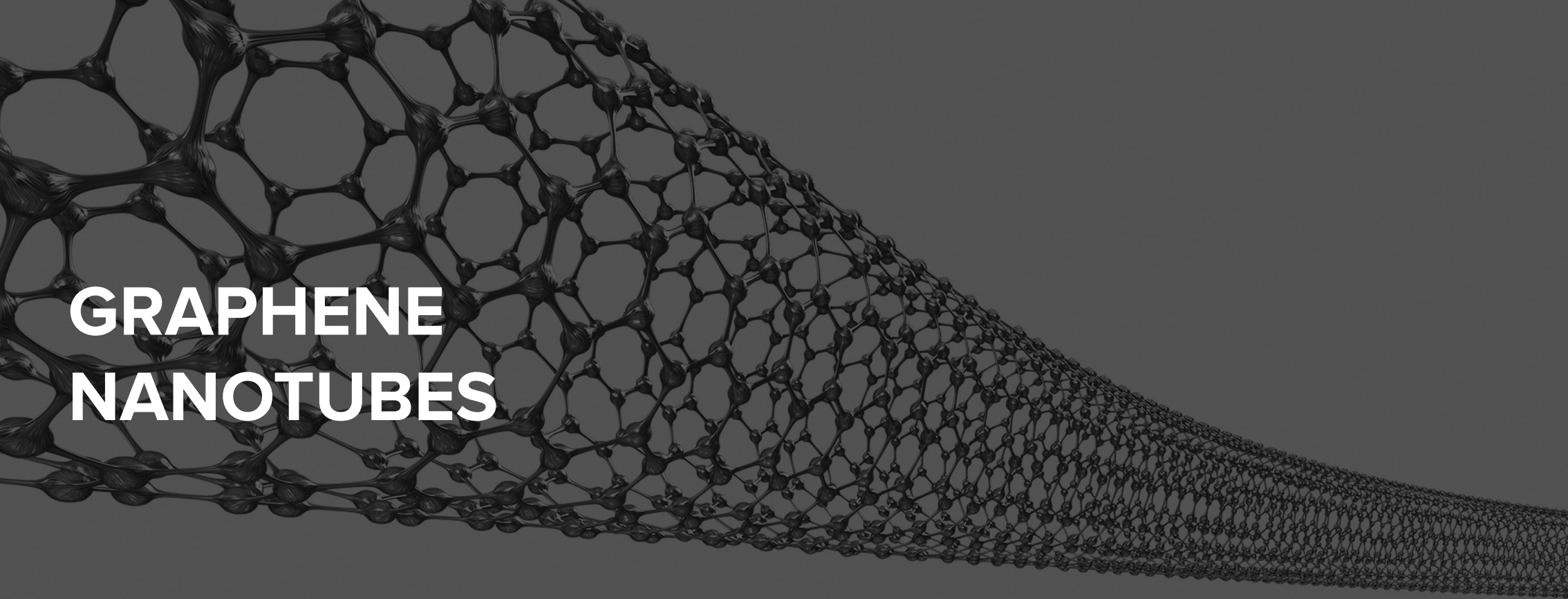
6  
C

# PRODUCT CATALOG

MAY 2022

# TABLE OF CONTENTS

<b>GRAPHENE NANOTUBES</b>	4
TUBALL™	
<b>PRODUCTS FOR:</b>	
<b>ENERGY STORAGE</b>	14
TUBALL™ BATT H <sub>2</sub> O	
TUBALL™ BATT NMP	
<b>ELASTOMERS</b>	32
TUBALL™ MATRIX 600-x series	
TUBALL™ LATEX	
<b>COMPOSITES &amp; COATINGS</b>	56
TUBALL™ MATRIX 200 / 300-x series	
TUBALL™ COAT_E	
<b>THERMOPLASTICS</b>	70
TUBALL™ MATRIX 800-x series	
<b>SAFETY INFORMATION</b>	82
<b>ABOUT OCSiA</b>	84
<b>CONTACTS</b>	86



# GRAPHENE NANOTUBES

**TUBALL™**

Diameter

 **$1.6 \pm 0.4$  nm**

Length

 **$>5$   $\mu\text{m}$** 

## GRAPHENE NANOTUBES

Human existence is shaped by the materials we use. More than 70% of all basic materials can be improved by introducing a universal additive: single wall carbon nanotubes. These tiny tubes provide us with a rare opportunity to create nanoaugmented materials that have extraordinary properties.



Single wall carbon nanotubes (SWCNTs) should be referred to as graphene nanotubes (GNTs) because each nanotube is an extremely thin rolled-up sheet of graphene. The superiority of graphene nanotubes is due to their exceptional properties, such as superior conductivity, high temperature resistance, strength and flexibility.



## TUBALL™

While the huge potential of GNTs has been recognised for many years, until recently their wide application in industry was not possible because of an absence of technology for their mass production, their high price, and a lack of methods for introducing them into materials.

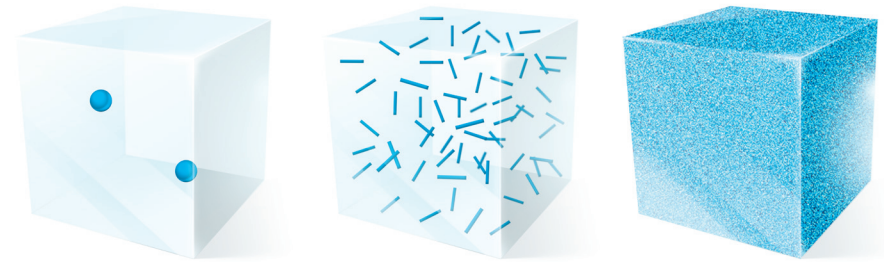
TUBALL™ nanotubes are the first GNTs to be available for commercial applications in a wide range of industries. OCSiAl's breakthrough yet low-cost mass-production technology has made the widespread use of nanotubes economically viable while still preserving their high quality.

## FEATURES

- Best price-to-performance ratio compared with similar products
- Maintains color, elasticity, durability and other key properties
- Versatile for an extremely wide range of applications
- High-quality nanotubes (G/D ratio >90)
- Benefits start from ultra-low concentrations
- Adds uniform, permanent and stable electrical conductivity
- Enhances mechanical properties of materials

## HOW IT WORKS

TUBALL™ provides significant improvements in material properties upon the addition of ultra-low loadings – starting from only 0.01%.



Microparticles

Nanofibers

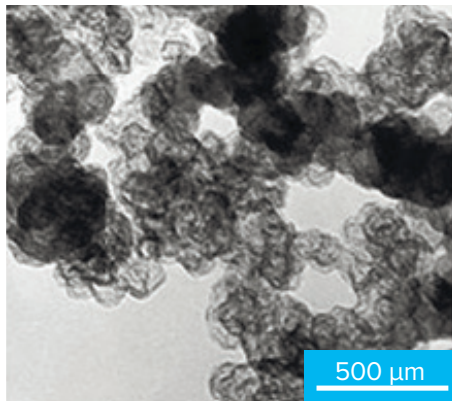
GNTs

The same concentration of particles (~0.1%) in the same volume.

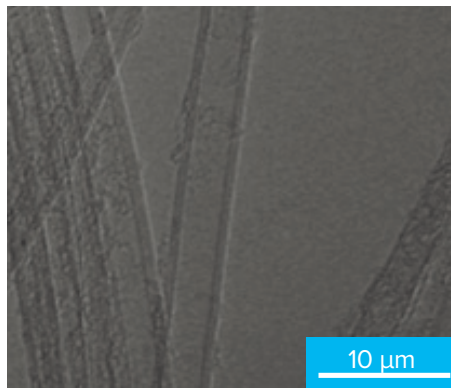
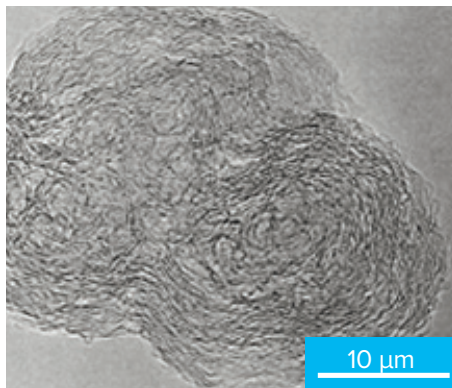
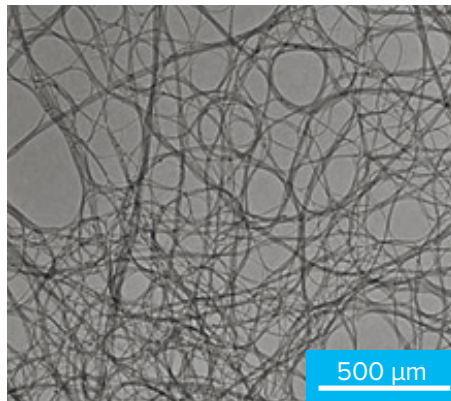
Unlike conventional additives such as multi wall carbon nanotubes, carbon fibers, and most types of carbon black that unevenly disperse in a material's matrix, GNTs create a 3D uniform reinforced and conductive network.\*

## NANOTUBES: THE ULTIMATE CARBON ADDITIVE

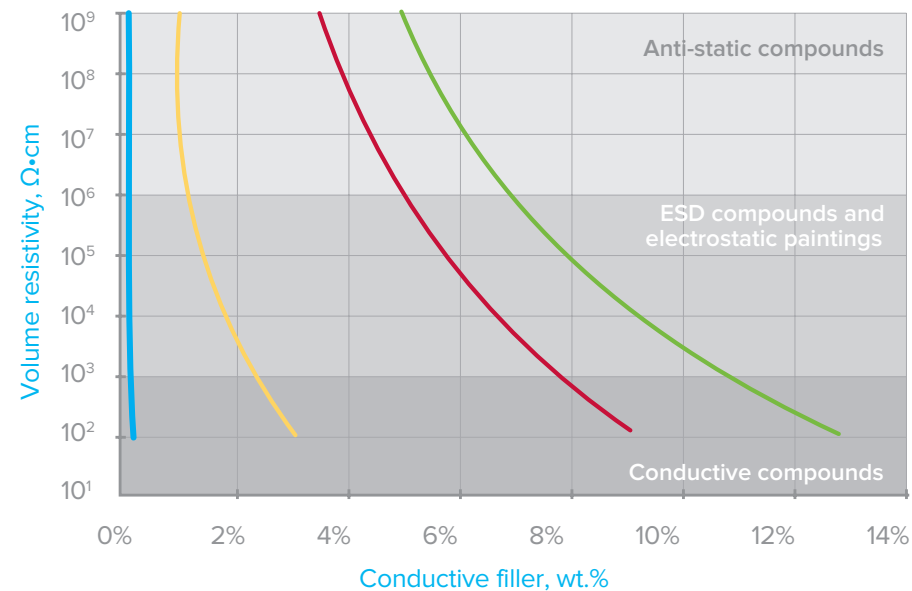
Conductive carbon black



TUBALL™ graphene nanotubes



## THERMOSETS WITH TUBALL™ SHOW A SIGNIFICANT INCREASE IN CONDUCTIVITY



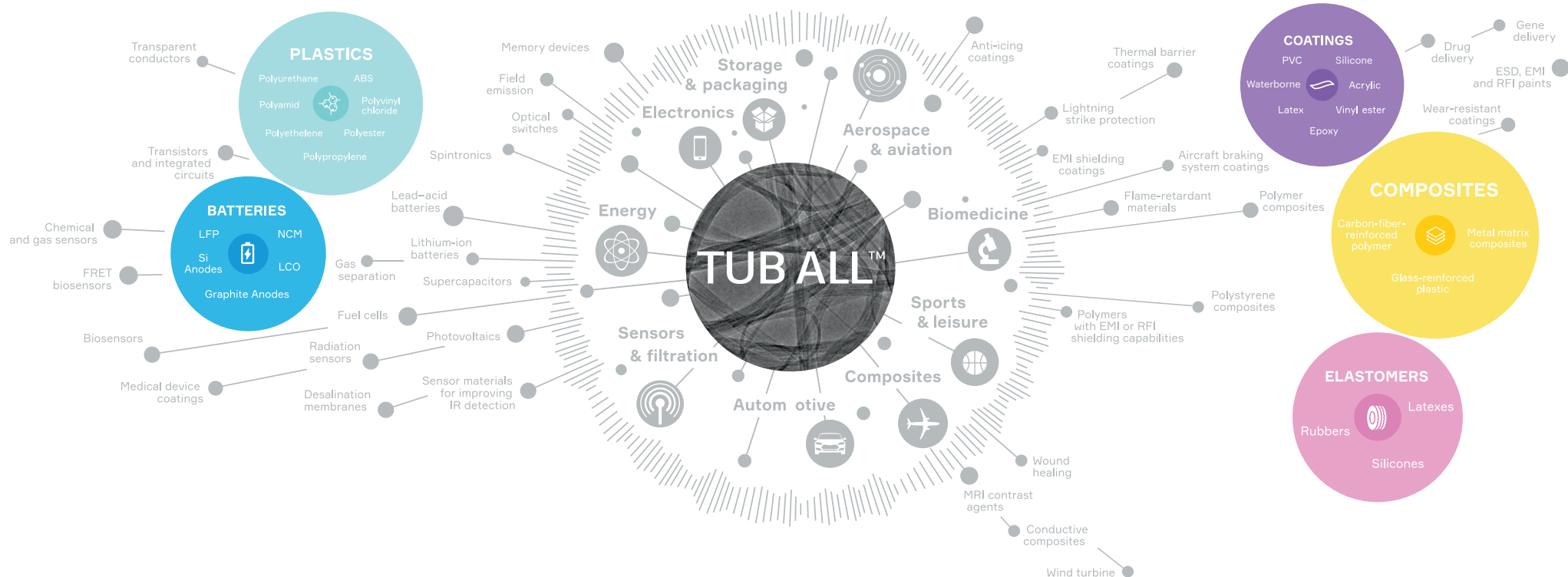
- TUBALL™ graphene nanotubes
- Multi wall CNT
- Premium carbon black
- Conductive carbon black

Results for unfilled polyester resin. ASTM D257.

## TRULY UNIVERSAL ADDITIVE

To easily and properly incorporate TUBALL™ into materials, OCSiAl has developed and successfully brought to market a line of pre-dispersed concentrates, masterbatches and suspensions that are compatible with various industry-standard formulations.

For more information on TUBALL™ application in a specific matrix, refer to the product listing in the catalog or contact the nearest OCSiAl office for assistance in selecting the right solution.



A blurred, grayscale background image showing an electric car parked at a charging station. The car is positioned horizontally across the frame, and a charging cable is visible on the right side, connected to the vehicle. The overall image has a soft, out-of-focus quality.

# **PRODUCTS FOR ENERGY STORAGE**



# TUBALL™ BATT

TUBALL™ BATT is a ready-to-use dispersion designed to easily incorporate TUBALL™ into electrode formulations during the battery manufacturing process.

TUBALL™ BATT provides a complete or partial substitute for carbon black in battery electrodes and can replace several percent of carbon black with 0.03–0.1% of TUBALL™.

TUBALL™ forms conductive 3D networks between active material particles at very low concentrations. The nanotubes reinforce the electrode structure and improve its mechanical stability during cycling. TUBALL™ improves adhesion by establishing strong ties between the particles, reducing the amount of binder required.





# TUBALL™ BATT H<sub>2</sub>O

**Ultra-fine TUBALL™ dispersion in H<sub>2</sub>O  
for high-energy Si-based anodes**

Nanotube dispersion in water creates a robust network inside the Si-anode and solves the problem of its degradation, allowing Li-ion battery makers to use record high quantities of silicon in the recipes of their cells for the first time and reach desired energy density targets, as well as unlocking fast-charging capabilities. The key element of Si-based anodes in the majority of silicon anode projects worldwide.

## FEATURES

- Compatible with the majority of state-of-the-art SiO or Si/C anode recipes
- CMC or other binders available
- Low content of foreign impurities
- Ready, easy to use, efficient: proven by leading Li-ion battery makers

## CUSTOMER CASE

**Customer:** 3C battery maker

**Product:** Pouch cells for mobile phones

**Why TUBALL™:** Improving volumetric density of the battery is required

**Dosage in recipe:** 0.05%–0.1% of TUBALL™ in SiOx + graphite in anode slurry recipe

**The result:** 800 Wh/l volumetric density is achieved with a good cycle life performance

## BENEFITS



### Solves the Si-anode degradation problem

20% of SiO/C anodes with up to 600 mAh/g of capacity thanks to TUBALL™ BATT H<sub>2</sub>O result in a battery cycle life acceptable to the modern EV industry



### Record high energy density achievable

Boosts energy density up to 300 Wh/kg and 800 Wh/l due to Si-anode enabling



### Fast-charging ability unlocked

Up to 4C charge-rate achievable due to high silicon content enabled by TUBALL™



### Cycle life that meets the targets of the modern EV industry

Makes it possible to retain >80% capacity after 1,500 cycles



# TUBALL™ BATT NMP

Ultra-fine TUBALL™ dispersion in NMP  
for high-energy cathodes

Unmatched TUBALL™ conductivity for improved battery safety and energy density now comes in a more cost-efficient and optimized dispersion.

## FEATURES

- Dispersion optimized specially for cathodes
- More than 80% solids achievable
- Low Fe content
- Choice of PVDF possible
- Ready and easy to use

## CUSTOMER CASE

**Company:** Manufacturer of cylindrical batteries for various applications

**Product:** Cylindrical battery 18650

**Why TUBALL™:** Too much heat from high discharge rate mode as well as not enough power at lower temperatures

**Dosage in recipe:** 0.04%–0.08% of TUBALL™ in cathode slurry recipe

**The result:** DCR decreased significantly, improved continuous discharge rate at 0 °C

## BENEFITS



### Boosted energy density

Thanks to 10–60 times lower loading of conductive additive. Up to 98.8% active material content possible in dry electrode



### Higher discharge power

Increases >50% at high discharge rates



### Higher safety

Increased safety due to twice lower battery resistance increase (DCR)



### Improved adhesion

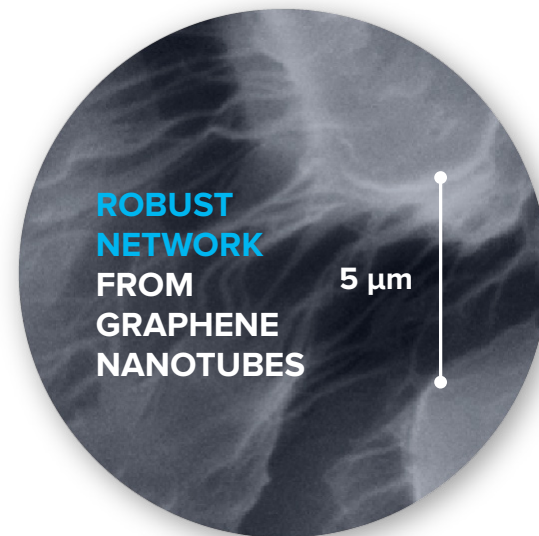
Twice higher thanks to the bond strength between cathode particles

# ANODE

TUBALL™ graphene nanotubes cover the surface of the silicon particles and create highly conductive and durable connections between them. These connections are so dense, long, conductive and strong that, even when the silicon particles in the anode expand and the material starts to crack, the particles stay well connected to each other through the TUBALL™ graphene nanotubes. This prevents the anode from going out of service – the hugely improved cycle life is enough to meet even the most strict EV manufacturer requirements.

## TUBALL™ UNLOCKS MASS PRODUCTION OF EV BATTERIES WITH SILICON ANODES

Bridging silicon anode particles and preventing their degradation during silicon volume expansion and cracking



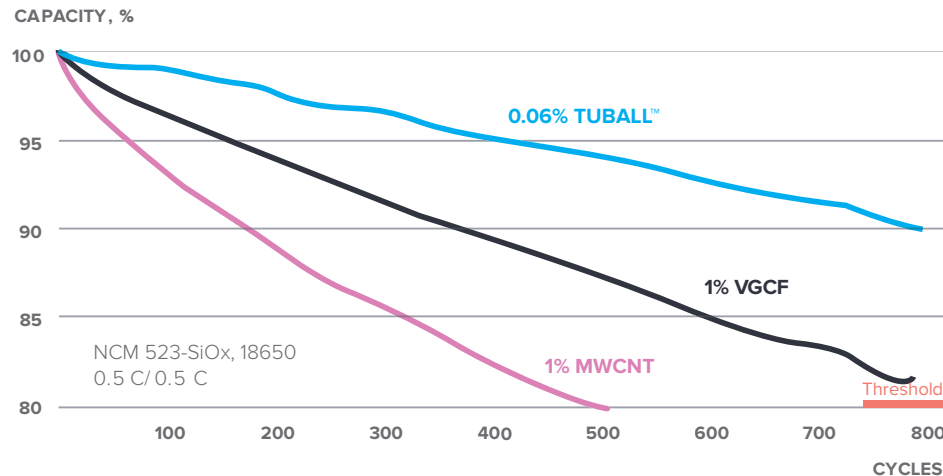
**ROBUST  
NETWORK  
FROM  
GRAPHENE  
NANOTUBES**

5 μm

**TUBALL™ SOLVES THE SILICON ANODE PROBLEM – PREVENTING ITS DEGRADATION**



## TUBALL™ NETWORKS INCREASE SILICON-BASED ANODE CYCLE LIFE BY UP TO 4 TIMES



Leading Li-ion manufacturers have proven that TUBALL™ nanotubes make it possible today to create anodes containing 20% SiO and thus reach record-breaking battery energy densities – up to 300 Wh/kg and 800 Wh/l.

This enables fast-charging capabilities. Such battery cells can deliver up to +15% higher range than the best Li-ion battery cells on the market!

**20%** SiO with TUBALL™  
in Li-ion batteries  
is just the beginning

# WE CAN GO FURTHER

**90%**

SiO is possible  
with TUBALL™

**350**

Wh/kg  
energy density  
can be achieved

OCSiAl R&D team results show that it's possible to increase the SiO content in anodes to 90%, which will result in energy density of 350 Wh/kg.

# CATHODE

Thanks to their unique intrinsic properties, graphene nanotubes outperform alternatives and offer substantial Li-ion battery performance improvements in terms of energy density, safety, discharge power, and adhesion. Such performance improvements for Li-ion battery cathodes cannot be demonstrated by any traditional conductive additives, such as carbon black or multi wall carbon nanotubes.

## TUBALL™ IMPROVES KEY PARAMETERS

In comparison with MWCNT and carbon black cathode formulas:

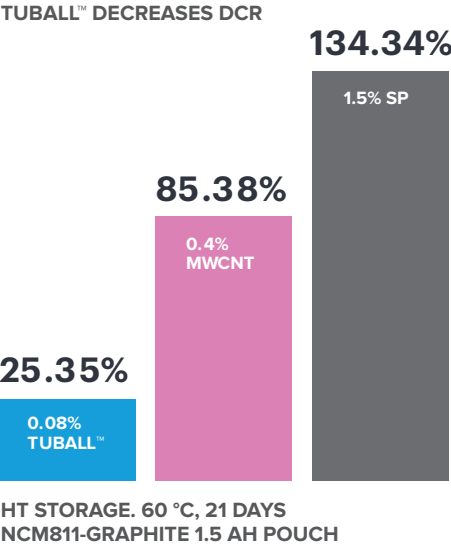
SAFETY	ENERGY DENSITY	DISCHARGE POWER	ADHESION
higher due to	higher due to	higher	higher up to
<b>2×</b>	<b>10–60×</b>	<b>&gt;50%</b>	<b>2×</b>
lower battery resistance increase (DCR) during high-temperature (HT) storage and cycling	lower loading	at high discharge rates >3C	nanotubes increase the bond strength between cathode material particles

# Safety

Being the most conductive material that can be used in the formulation of Li-ion batteries, even a small amount of TUBALL™ graphene nanotubes is enough to reduce internal battery cell resistance (DCR). Stable TUBALL™ networks are maintained inside the cathode material even after multiple battery charge–discharge cycles and battery storage periods, enabling the DCR to be maintained at a low level as well — after high-temperature storage and cycling.

60%  
lower resistance increase during  
high-temperature battery storage

The lower battery DCR results in lower temperature build-up, and thus a reduced risk of a battery fire. This is a crucial safety benefit, made possible by TUBALL™ graphene nanotubes.



# Energy density

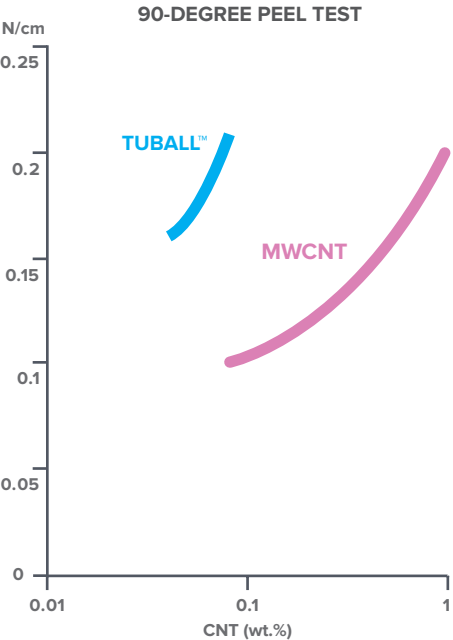
Less than 0.1% of TUBALL™ provides higher energy density. This concentration is lower by 10–60 times than that needed when using multi wall carbon nanotubes or carbon black as a conductive additive. In a modern EV battery pack, 5 kg of conductive carbon black can be replaced by just 100 g of TUBALL™.

# Discharge power

Thanks to the unmatched conductivity of graphene nanotubes compared with other conductive additives, using TUBALL™ in cathodes makes it possible to achieve fast discharging while also increasing the battery's capacity.

# Cathode adhesion

Nanotube networks hold the cathode material particles together, increasing the bond strength between them.



TUBALL™ BATT READY-TO-USE PRODUCTS FOR LIBs

	GNTs, %	DISPERSING AGENT, %	METAL IMPURITIES, PPM	DESCRIPTION
FOR CATHODES				
				<b>ULTRA-FINE TUBALL™ DISPERSION IN NMP</b> for high-energy and high-power cathodes
0.4% TUBALL™ BATT NMP	0.4%	PVDF 2%	<40	<b>Maximizes energy density</b> when used as a full or partial replacement of other conductive additives  <b>Boosts C-rate, and reduces impedance</b> when used low dosage in combination with other additives
FOR Si/C ANODES				
				<b>ULTRA-FINE TUBALL™ DISPERSION IN H<sub>2</sub>O</b> for high-energy Si/C anodes
0.4% TUBALL™ BATT H <sub>2</sub> O	0.4%	CMC 0.6%	<40	<b>Improves cycle life of Si/C anodes</b> , enabling their industrial adoption in hi-energy cells  <b>&gt;240 Wh/kg – benefits start.</b> The more that high-energy-density anodes are used, the more essential is the application of TUBALL™ GNTs





# **PRODUCTS FOR ELASTOMERS**

## APPLICATION EXAMPLES



Non-marking solid tires



Cables



Textile coatings



Conveyor belts and rollers



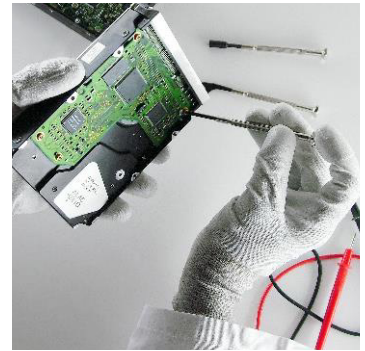
O-rings, hoses, jackets,  
heat-resistant cords and plates



Pressure-sensitive adhesive film



Rubber seals



ESD gloves



# TUBALL™ MATRIX FOR SILICONES

TUBALL™ MATRIX 601, 602 and 605 are nanotube concentrates specifically designed to provide superior electrical conductivity to silicone compounds (LSR – liquid silicone rubber, RTV – room temperature vulcanized rubber, and HCR – high consistency rubber) while retaining mechanical properties and minimally impacting the host matrix.



# TUBALL™ MATRIX 601 / 602 / 605

**PROPERTY** — Electrical conductivity



**TUBALL™ MATRIX 601**

**Carrier:**  
polydimethylsiloxane oil

**KEY APPLICATIONS**

- LSR (liquid silicone rubber)
- RTV (room temperature vulcanised) silicones

**TUBALL™ MATRIX 602**

**Carrier:** vinyl-terminated  
polydimethylsiloxane

**KEY APPLICATIONS**

- LSR (liquid silicone rubber)
- HCR (high consistency rubber)

**TUBALL™ MATRIX 605**

**Carrier:** silicone gum

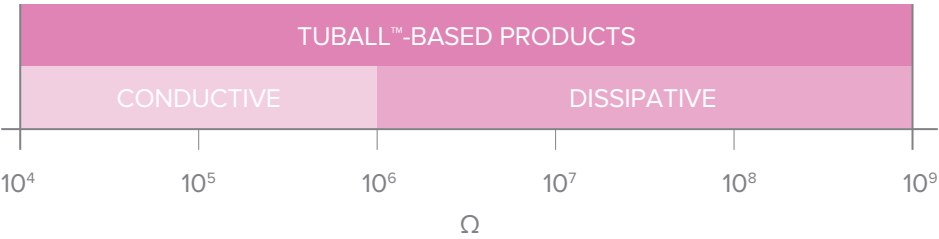
**KEY APPLICATIONS**

- HCR (high consistency rubber)

**CONDUCTIVE SILICONES WITH TUBALL™ MATRIX**

	Currently available	TUBALL™ MATRIX
Volume resistivity level	<100–10 <sup>8</sup> Ω·cm	<100–10 <sup>8</sup> Ω·cm
Concentration of conductive filler	30–70 wt.%	0.5–5 wt.%
Retain mechanical properties	No	Yes
Allow coloration	No	Yes

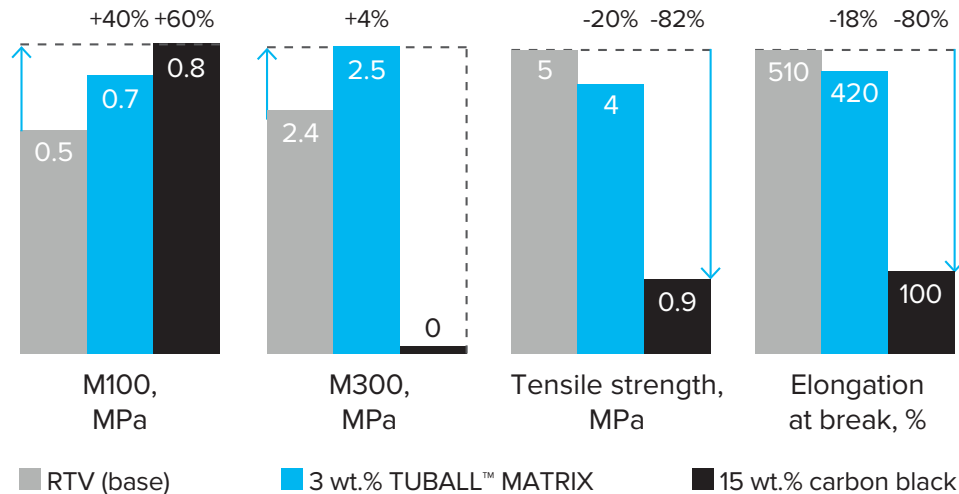
**FULL RANGE OF RESISTIVITY**





## MECHANICAL PROPERTIES OF RTV WITH 3 wt.% TUBALL™ MATRIX 601 IN COMPARISON WITH CONDUCTIVE CARBON BLACK\*

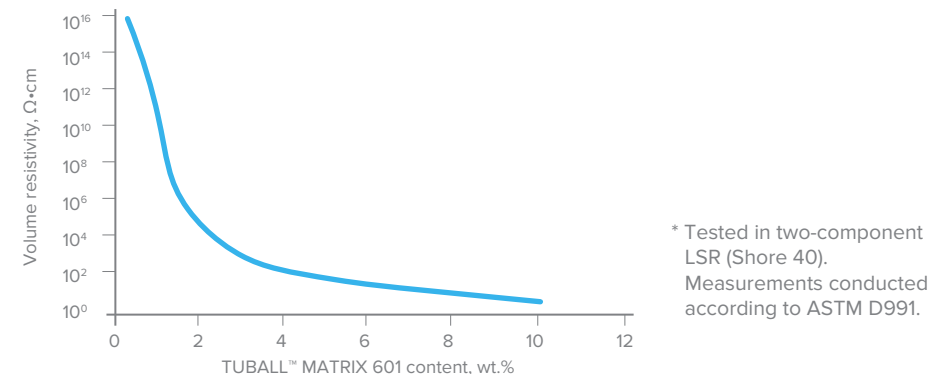
Volume resistivity 200  $\Omega \cdot \text{cm}$



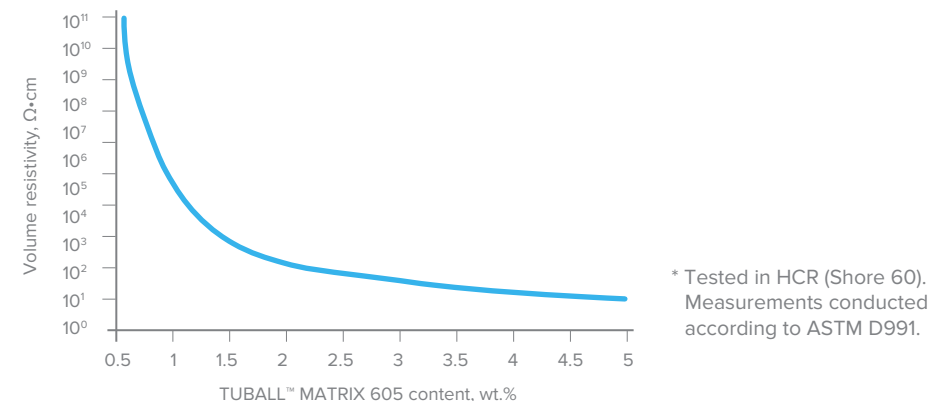
TUBALL™ MATRIX makes it possible to produce conductive compounds without impairing flexibility or mechanical properties

\* Measurements conducted according to ASTM D412.  
Study was conducted with conductive carbon black VULCAN® XC72R.

## VOLUME RESISTIVITY OF LSR SILICONE WITH TUBALL™ MATRIX 601 IS IN THE RANGE 10–10<sup>16</sup> $\Omega \cdot \text{cm}$ \*



## VOLUME RESISTIVITY OF HCR SILICONE WITH TUBALL™ MATRIX 605 IS IN THE RANGE <10–10<sup>11</sup> $\Omega \cdot \text{cm}$ \*



# TUBALL™ MATRIX FOR RUBBERS

TUBALL™ MATRIX 600-x series are nanotube concentrates designed to impart required electrically conductive properties to rubbers and to significantly enhance their mechanical properties.



# TUBALL™ MATRIX 610 / 620

**PROPERTY** — Electrical conductivity



## TUBALL™ MATRIX 610

**Carrier:** Polymer,  
paraffinic mineral oil

### KEY APPLICATIONS

- EPDM

## TUBALL™ MATRIX 620

**Carrier:** Polymer,  
TDAE oil

### KEY APPLICATIONS

- NR
- BR

## FEATURES OF TUBALL™ MATRIX FOR RUBBERS:

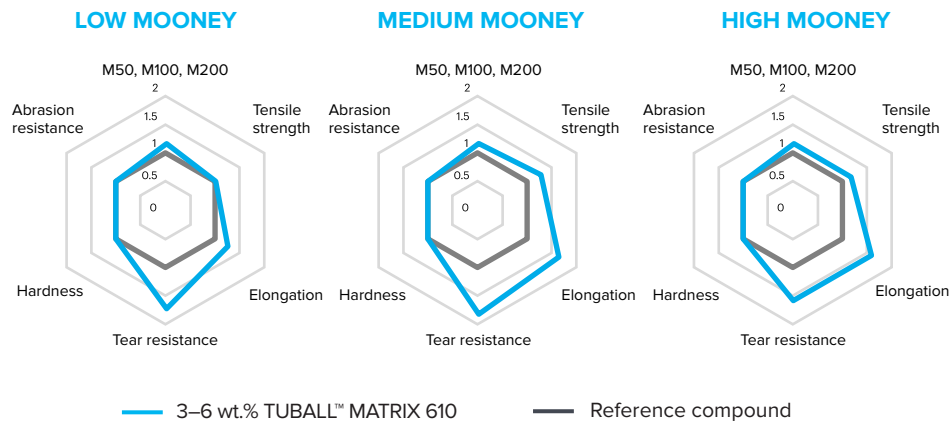
- Suitable for anti-static, static dissipative, and conductive applications
- Extremely low loadings of nanotubes that preserve properties
- Retain mechanical properties including softness
- Maintain rheology and viscosity
- Standard processing and mixing equipment
- Allows for colored ESD compounds

Ensuring long service life and stable conductive properties to crucial products and processes, nanotube-modified rubbers are widely used in the electronics, automotive, and tire, oil & gas, and other industries.

OCSiAl has developed a variety of products based on TUBALL™ graphene nanotubes for EPDM, NBR, SBR, blends of NR/BR, FKM, and other types of rubbers.

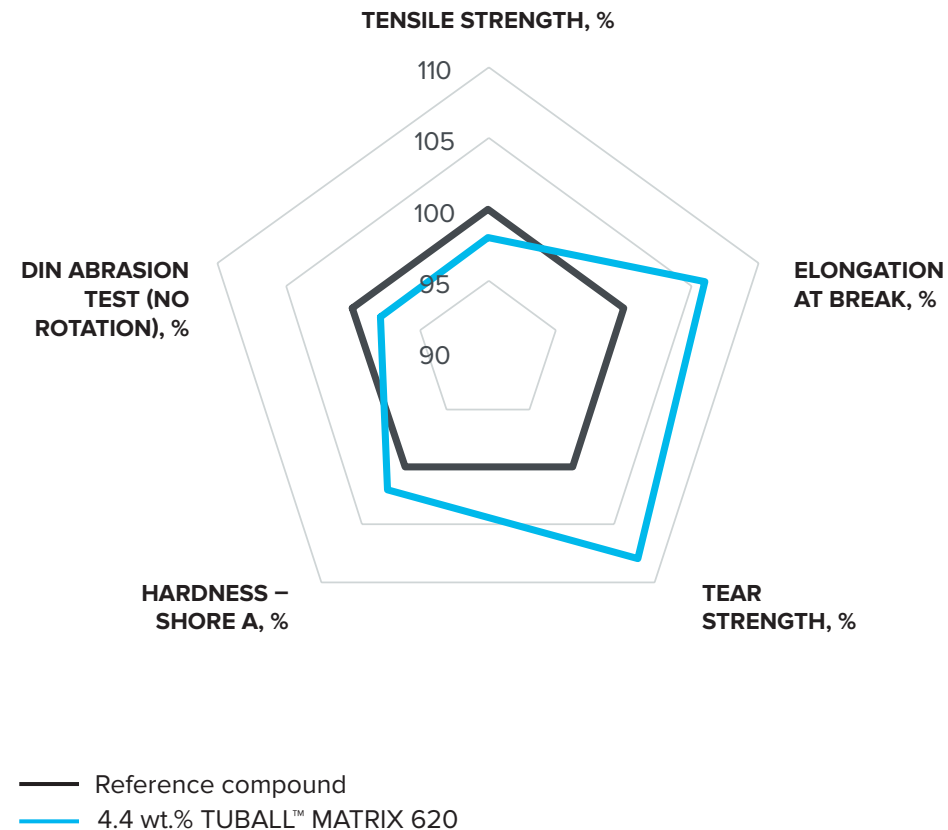


## IMPROVEMENT OF TEAR STRENGTH AND TENSILE PARAMETERS EVALUATION IN 3 VISCOSITY TYPES OF EPDM



- M50, M100, M200 increased by 15–20%
- Tensile strength increased by 16–23%
- Tear resistance increased by 25–103%
- Abrasion resistance increased by 3–11%
- No drawback in elasticity
- Electrical resistivity  $10^6$ – $10^9$   $\Omega \cdot \text{cm}$

## MECHANICAL PROPERTIES OF ANTI-STATIC NON-MARKING NR/BR SILICA BASED COMPOUND WITH TUBALL™ MATRIX 620



# TUBALL™ LATEX

TUBALL™ LATEX is a water-based suspension for manufacturing latex gloves and latex products with anti-static properties, while retaining mechanical properties and minimally impacting the host matrix.

TUBALL™ LATEX makes it possible to attain permanent and humidity-independent conductivity that is fully compliant with the most demanding applications, including the new European standard EN 16350:2014 (EN 1149) for anti-static properties in safety wear.





TOUCHSCREEN OPERATION WITH INDUSTRIAL GLOVES

TUBALL™ graphene nanotubes provide an anti-static effect that allows smooth operation of touchscreens without gloves having to be removed and that ensures worker and product protection.

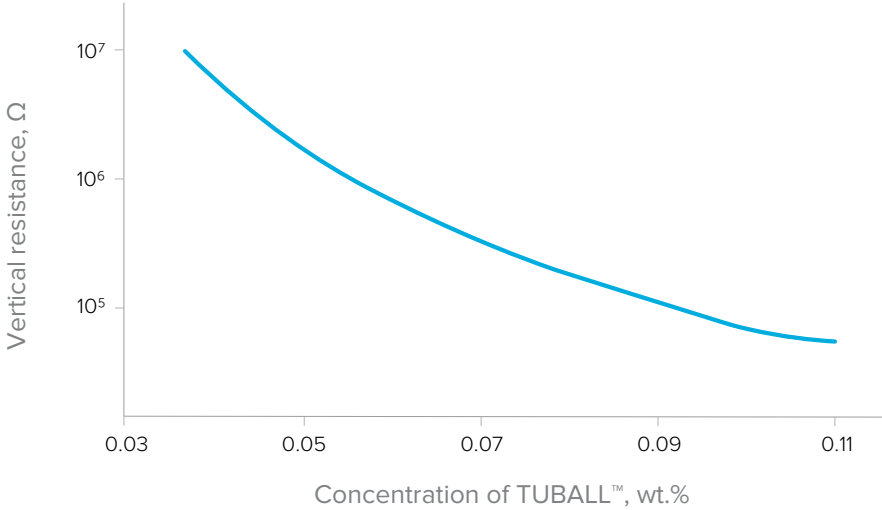
KEY BENEFITS

- Stable ESD properties according to international standards for protective wear
- Standard liners without conductive yarns
- No changes in formulation or dipping process
- Allows coloration



ANTI-STATIC NITRILE LATEX WITH TUBALL™

	Current solutions	Results with TUBALL™
Specific resistance level	$10^7\text{--}10^{11}\ \Omega$	$10^2\text{--}10^{11}\ \Omega$
Concentration of conductive filler	5–25 wt.%	0.03–0.075 wt.%
Negative impact on mechanical properties	Yes	No
Color retention	No	Yes



Measurement of electrical resistivity according to EN 16350:2014 carried out on teraohmmeter: TO-3 cable; electrode type - TE 50 for textile measurement (DIN 54345-1, DIN EN 1149-1 and DIN EN 1149-2)

**ESD GLOVES WITH TUBALL™**  
**PU & NITRILE LATEXES**

**LINER PU GLOVE**  
industrial  
0.06 wt.%



**NITRILE LATEX GLOVE**  
cleanroom  
0.06 wt.%



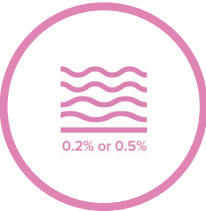
**LINER NITRILE GLOVE**  
industrial\*  
0.06-0.1 wt.%



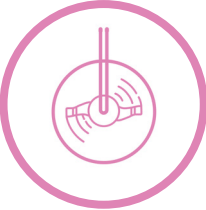
**ELECTRICAL RESISTANCE 10<sup>7</sup> Ω**

\*Gloves made by industrial partners with TUBALL™

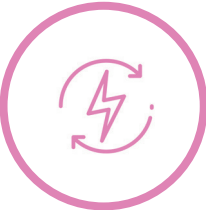
**HOW TO MAKE YOUR GLOVES CONDUCTIVE WITH TUBALL™**



User-friendly water-based dispersion  
available in two concentrations of TUBALL™









Standard compounding and dipping process



Touchscreen gloves compliant with international  
standards for protective wear

TUBALL™ GRAPHENE NANOTUBE SOLUTIONS FOR ELASTOMERS

PRODUCT	CARRIER MEDIUM	TARGET SYSTEMS						
		LSR silicone	RTV silicone	HCR silicone	EPDM	NR	BR, IR, SBR	NBR, PU, NR latex
SILICONES								
	Polydimethylsiloxane	●	●					
	Siloxanes and silicones vinyl group-terminated	●	●	●				
	Siloxanes and silicones vinyl group-terminated			●				
LATEX								
	Water, anionic surfactant							●
RUBBERS								
	Polymer, paraffinic mineral oil				●			
	Polymer + plasticizer					●	●	

The background image shows a large industrial facility, likely a composite manufacturing plant. On the left, a series of green vertical support structures or machinery extend into the distance. The floor is highly reflective, mirroring the green structures and the bright overhead lights. In the far background, several workers in safety gear are visible near some equipment and materials. The overall scene is clean, organized, and brightly lit.

# **PRODUCTS FOR COMPOSITES & COATINGS**

# TUBALL™ MATRIX 200 / 300-X SERIES

TUBALL™ MATRIX 200 / 300-x series are nanotube concentrates designed to provide permanent, uniform electrical conductivity to various materials: epoxy, polyurethane, polyester, etc. TUBALL™ MATRIX is compatible with a variety of color shades while meeting ESD standards.





## APPLICATION EXAMPLES



GFRP pipes



Equipment for mines, electronics, chemical plants and petrol stations



Epoxy and PU anti-static flooring



Gelcoats and moldcoats



Industrial rollers



Housing/package for sensitive electronics, and combustible powders or liquids

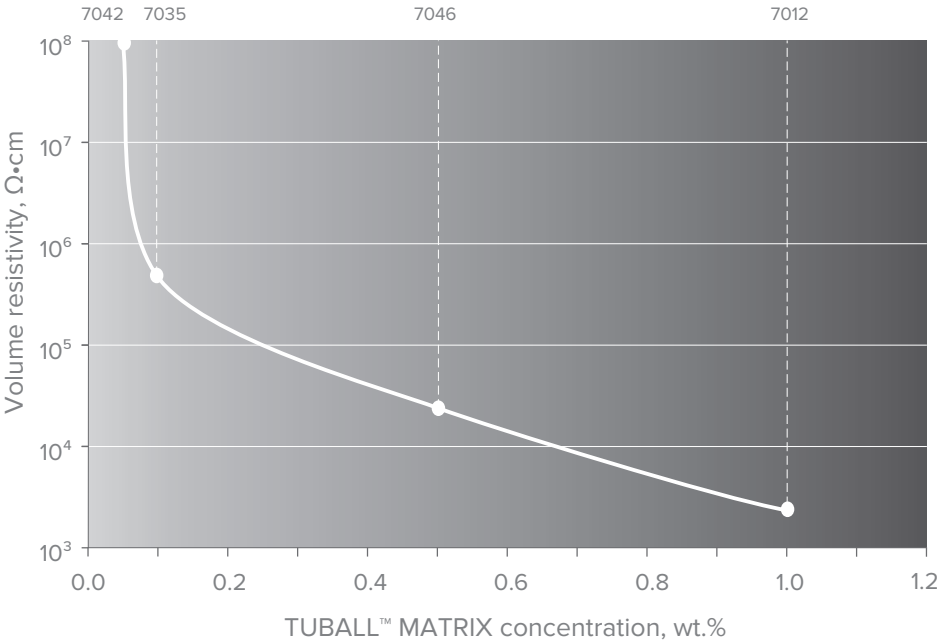
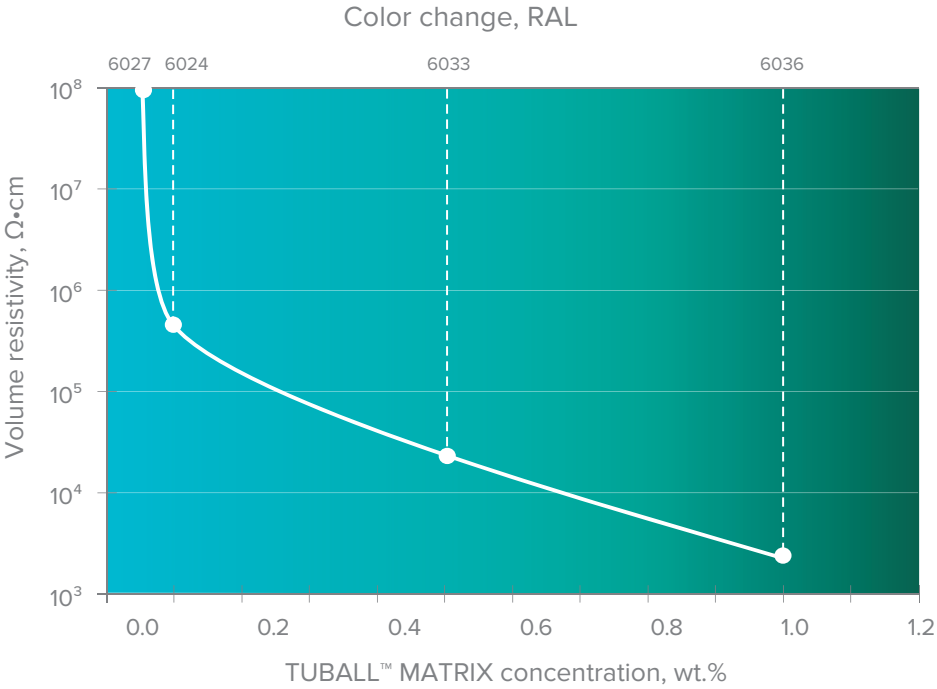


Lining coatings



Conductive primers for plastic components

TUBALL™ MATRIX CONDUCTIVITY AND COLOR



**Note:** all samples include 5 wt.% of  $\text{TiO}_2$  as a whitening agent.  
Results for epoxy resin D.E.R. 351. ASTM D257

# TUBALL™ COAT\_E

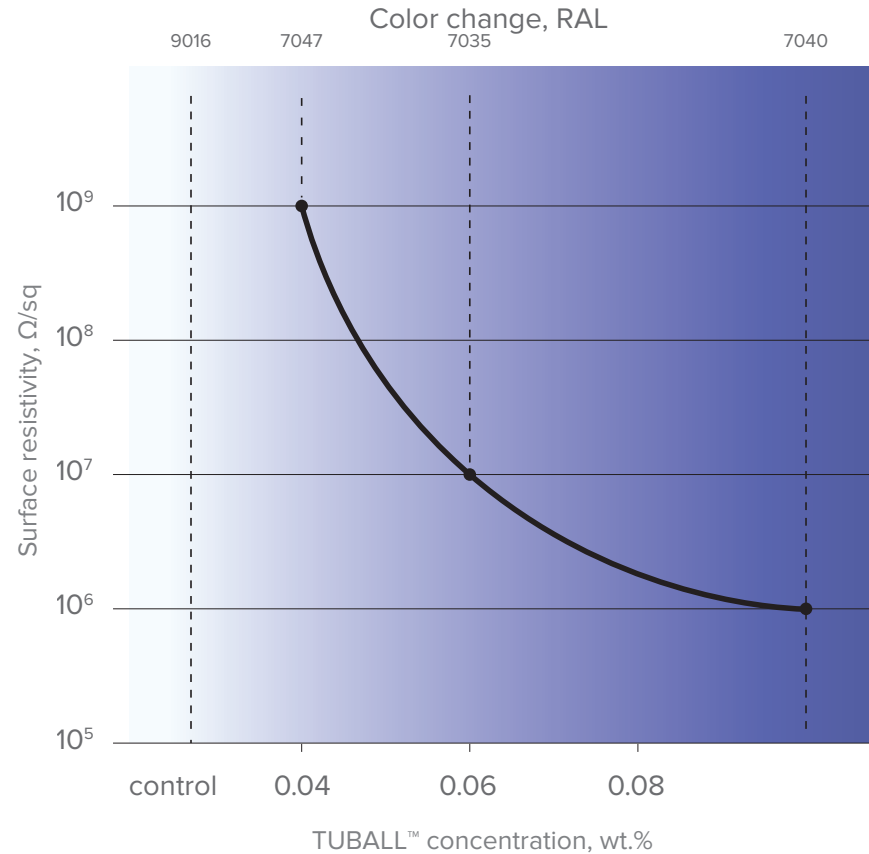
TUBALL™ COAT\_E is an easy-to-use single wall carbon nanotube suspension in water that provides permanent anti-static properties to waterborne paints and coatings with minimal impact on their color and mechanical properties.

TUBALL™ COAT\_E is suitable for production of anti-static waterborne paints and coatings intended for the following applications:

- UV coating
- Packaging for electronics

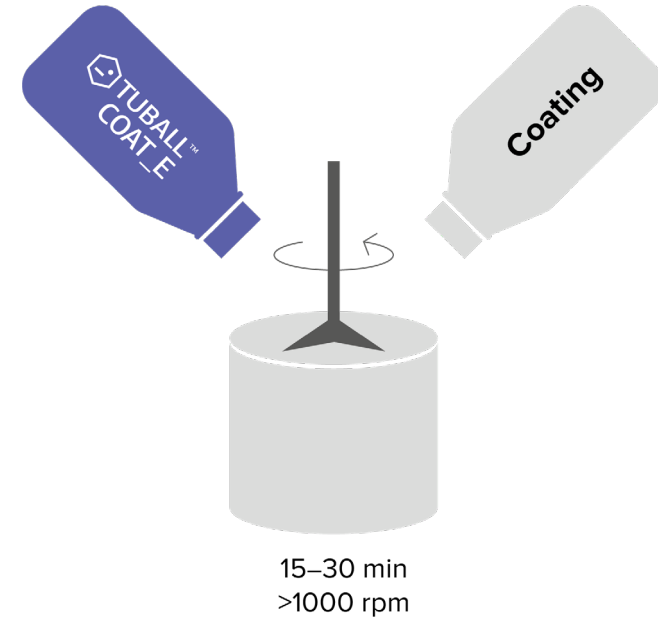


## TUBALL™ COAT\_E IS SUITABLE FOR COLORED AND TRANSPARENT SYSTEMS














Permanent electrostatic dissipative and conductive properties with color and/or transparency are achieved by simply mixing TUBALL™ COAT\_E with the paint system.

- Easy to use
- Efficient ESD protection
- Permanent conductivity
- Suitable for colored and transparent systems



## TUBALL™ GRAPHENE NANOTUBE SOLUTIONS FOR COMPOSITES & COATINGS

PRODUCT	CARRIER	COMPOSITION	Target systems															
			Solvent-free				Solvent-based							Water-based				
			Epoxy	Polyester	Vinyl-ester	Polyurethane	Epoxy	Polyester	Vinyl-ester	Polyurethane	Melamine	Phenolic resoles	Acrylic	Epoxy	Polyurethane	Acrylic	Phenolic resoles	
TUBALL™ MATRIX concentrates (Black flakes paste @ standard dosage 0.1%–1.0%)																		
	Plasticizer	Fatty acid glycidyl ester (2,3-epoxypropyl neodecanoate, CAS-No. 26761-45-5)	●															
	Plasticizer	Fatty carboxylic acid ester derivatives				●												
	Plasticizer + stabilizing agent	Fatty acid glycidyl ester (2,3-epoxypropyl neodecanoate, CAS-No. 26761-45-5) + ammonium salt of polyolefins-based derivative					●			●								
	Plasticizer + stabilizing agent	Triethylene glycol dimethacrylate (CAS No. 109-16-0) + ammonium salt of polyolefins-based derivative		●	●			●	●		●		●					
	Plasticizer	Alkyl glycidyl ether (Oxirane, mono[(C12-14-alkyloxy)methyl] derivative, CAS No. 68609-97-2)	●															
	Plasticizer + stabilizing agent	Alkyl glycidyl ether (Oxirane, mono[(C12-14-alkyloxy)methyl] derivative, CAS No. 68609-97-2) + ammonium salt of polyolefins-based derivatives					●			●								
	Plasticizer	Fatty carboxylic acid ester derivatives				●												
	Surfactant	Ethoxylated alcohol (C12-15-branched and linear, ethoxylated propoxylated, CAS No. 120313-48-6)	●			●												
	Surfactant + stabilizing agent	Alkylene glycol derivative + stabilizing agent ((disodium 2,2'-([1,1'-biphenyl]-4,4'diyldivinylene) bis (benzenesulphonate, CAS No. 27344-41-8))										●			●	●	●	
TUBALL™ suspensions COAT_E (Black liquid @ standard dosage 1.5%–6.4%)																		
 H <sub>2</sub> O 0.2/0.4% (SDBS)	Water + anionic surfactant	Water + anionic surfactant (sodium dodecylbenzenesulfonate, CAS No. 25155-30-0)												●	●	●		
 H <sub>2</sub> O (DBD) beta	Water + distyrylbiphenyl-derivative	Water + distyrylbiphenyl-derivative, (CAS No. 27344-41-8)												●	●	●		





# PRODUCTS FOR THERMOPLASTICS

# TUBALL™ MATRIX 800-X SERIES

TUBALL™ MATRIX 800-x series is a line of concentrates based on TUBALL™ graphene nanotubes that has been specifically designed to provide superior electrical conductivity to thermoplastic materials, while retaining mechanical properties and minimally impacting the host matrix.

TUBALL™ MATRIX 800 line is designed for the most demanding applications in the automotive, petrochemical, oil and gas, healthcare, pharmaceutical and electronics industries.





## APPLICATION EXAMPLES



ESD containers



Ventilation ducting



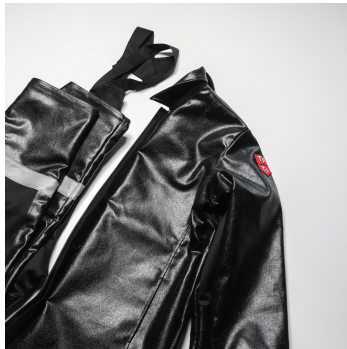
Anti-static signal lamps



Conductive compounds for e-painting



Semiconductive shielding materials



Anti-static textiles











Treadmill belts



Filled polyamide injection-molded part

## TUBALL™ FOR THERMOPLASTICS

PRODUCT	CARRIER	Target systems													
		Polyethylene	PE rotomolding	Polypropylene	EVA	PVC	Polystyrene	TPU	Filled PPS	ABS	PC	PC-ABS	PA	GF PA	Powder coatings
TUBALL™ MATRIX concentrates (Pellets or black flakes paste @ standard dosage 0.3%–3.0%)															
	Ethylene copolymer				●	●	●			●			●	●	
	Polyol ester							●	●	●	●	●	●	●	
	Alkylolammonium salt		●												
	Epoxidized fatty acid glyceride					●									
	Polyethylene wax	●	●	●											●
	Reaction mass of fatty acids, montan-wax, ethylene esters	●	●	●											●
	Polyol ester			●				●	●	●	●	●	●	●	
TUBALL™ suspensions COAT_E (Black liquid @ standard dosage 1.5%–6.4%)															
	Water + anionic surfactant		●												

\* PVC plastisol specific



# TUBALL™ MATRIX

## 808 / 814 / 822

**PROPERTY** — Electrical conductivity



### TUBALL™ MATRIX 808

**Carrier:** polyol ester

**Materials:** TPU, filled PPS, ABS, PC, PC-ABS, PA, GF PA

**Working dosage:**  
0.5–5 wt.%

**Shape:** pellets



### TUBALL™ MATRIX 814

**Carrier:** epoxidized soybean oil and polymeric stabilizing agent

**Materials:** PVC-plastisol

**Working dosage:**  
0.25–2 wt.%

**Shape:** paste



### TUBALL™ MATRIX 822

**Carrier:** polyol ester

**Materials:** PP, TPU, filled PPS, ABS, PC, PC-ABS, PA, GF PA

**Working dosage:**  
0.2–2 wt.%

**Shape:** pellets

## FEATURES OF TUBALL™ MATRIX FOR THERMOPLASTICS:

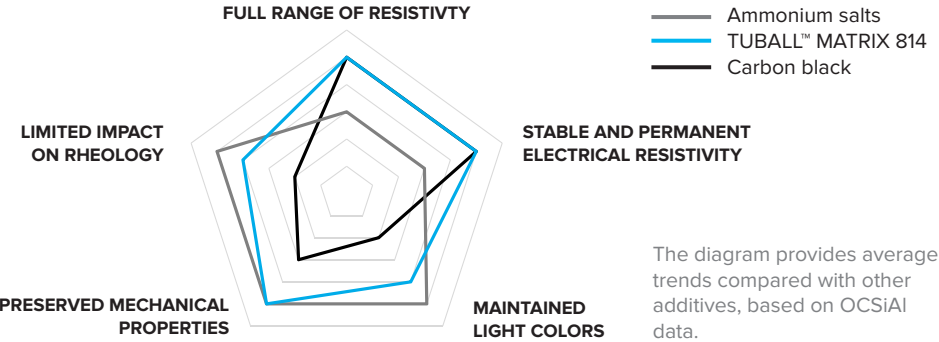
- Ultra-low dosage starting from just 0.05 wt.% of TUBALL™ graphene nanotubes\*
- Maintains good balance of mechanical properties
- Provides thermoplastic compounders with opportunity for new conductive products development
- Permanent, stable and homogenous electrical resistivity without “hot spots”
- Surface resistivity of  $10^3$ – $10^9$   $\Omega$ /sq\*
- Volume resistivity of  $10^3$ – $10^9$   $\Omega$ ·cm\*
- Stable performance reducing the number of out of spec parts
- Good processability
- Allows production of conductive parts that retain colors

\* Dosages and values can vary depending on the formulation, processing and products. The shown values are mentioned as the typical reference

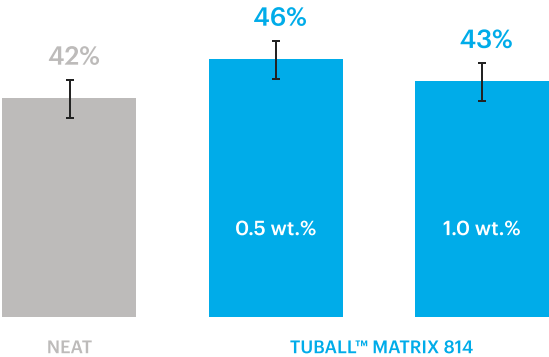


APPLICATION EXAMPLE: CONDUCTIVE PVC-PLASTISOL

TUBALL™ MATRIX is highly competitive conductive agent that enable a full set of properties.



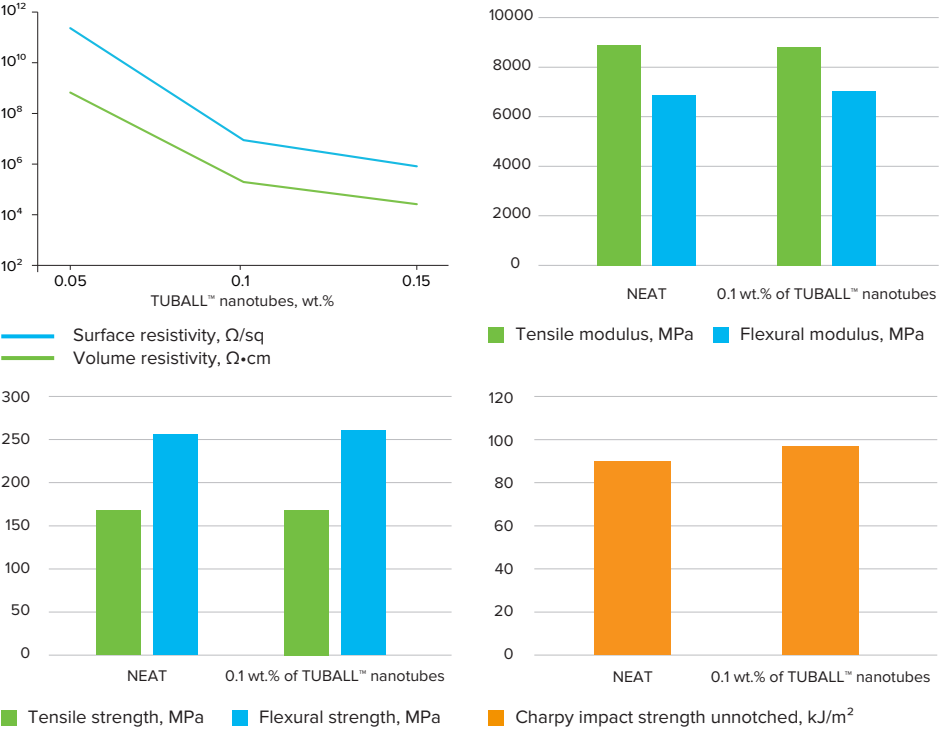
TUBALL™ MATRIX maintained abrasion resistance index.



OCSiAl internal PVC plastisol formulation. ASTM D5963-04.

APPLICATION EXAMPLE: CONDUCTIVE GLASS FIBER-FILLED POLYAMIDE

TUBALL™ MATRIX provides a full range of electrical resistivity while maintaining mechanical properties.



Injection molded samples. ISO 527, ISO 178, ISO 179.

## SAFETY INFORMATION

OCSiAl produces nanotube dispersions and concentrates to enable a simple and easy integration process. TUBALL™ MATRIX products and TUBALL™ suspension products were developed to minimize handling requirements and provide all manufacturers access to the superior performance of single wall carbon nanotubes.

For handling and safety information please refer to the Material Safety Data Sheet and Safe Handling guide for the corresponding product.



More at [tuball.com](https://tuball.com)

## WARRANTIES AND DISCLAIMER

The information provided by OCSiAl in this Product Catalog is for general informational purposes only and under no circumstances does it constitute an offer to enter into a binding agreement with OCSiAl.

OCSiAl makes every reasonable effort to ensure that all information in this Product Catalog is correct. However, OCSiAl makes no representation or warranty of any kind, whether express or implied, regarding the accuracy, completeness, appropriateness, or suitability of the information contained therein.

OCSiAl will not be liable for damages of any kind arising from the use of any information contained in this Product Catalog, including, but not limited to direct, indirect, incidental, punitive or consequential damages, unless otherwise specified in writing.



OCSiAl is the world's largest manufacturer of graphene nanotubes and owns the only scalable technology that can synthesize them in industrial volumes.

A graphene nanotube (also known as a single wall carbon nanotube) is a rolled-up sheet of graphene. High electrical and thermal conductivity, strength, and flexibility – all together, these exceptional properties allow graphene nanotubes to improve the properties of most known materials. When embedded into a material, the nanotubes create a 3D reinforcing and conductive network. OCSiAl produces high-purity graphene nanotubes under the TUBALL™ brand name.

OCSiAl accelerates the transformation process of nanotubes from the laboratory to being an industrial-scale material by simplifying their handling. The TUBALL™ MATRIX nanotube concentrate product line allows nanotubes to be used directly in standard manufacturing technological processes. Often as little as 0.1% of the concentrate is enough to improve a material's properties significantly.

So far, OCSiAl has developed TUBALL™-formulated technologies for electrochemical power sources, elastomers, composites,

plastics, paints and coatings. To provide its customers with advanced technical support and to develop new nanotube technologies, the company has launched TUBALL Centers in Asia and Europe.

OCSiAl's current production capacity is 90 tonnes per year. For industrial-scale commercialization in global markets, OCSiAl has registered its TUBALL™ single wall carbon nanotubes with regulators of various countries, including EU-REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and the US Environmental Protection Agency. It allows OCSiAl to commercialize up to 100 tonnes of single wall carbon nanotubes per year in Europe and unlimited tonnage in the US.

OCSiAl partners with more than 1,500 companies all around the world. Headquartered in Luxembourg, it is represented in the US, Korea, China, Hong Kong, Japan, India, Malaysia, CIS, Mexico and Australia. OCSiAl has over 450 employees, with around 70 of those being R&D experts.

450+ PEOPLE  
60+ SCIENTISTS  
1 DREAM





## CONTACT YOUR LOCAL DISTRIBUTOR TO ORDER A SAMPLE AND OBTAIN TECHNICAL/SAFETY DATA SHEETS

### ASIA

#### KOREA

208, Gaetbeol-ro 12,  
Yeonsu-gu, Incheon,  
21999, Korea  
+82 32 260 0407  
asiapacific@ocsial.com

#### HONG KONG

Room 1102, 11/F, Lippo Sun  
Plaza, 28, Canton Road,  
Tsim Sha Tsui, Kowloon,  
Hong Kong  
+852 3575 3946

#### CHINA

#2004, 20th floor, Tower B,  
Da Chong Business Centre,  
Yue Hai Street, Nanshan  
District, Shenzhen,  
Guangdong, China  
+86 755 867 00059

Ground floor, Unit 4,  
Building 7, No.160, Basheng  
Road, Pudong district,  
Shanghai, China  
+86 135 9012 5295

china@ocsial.com

### JAPAN

Tokyo, Japan  
070-1421-0331  
japan@ocsial.com

### INDIA

Vimal intertrade PVT Ltd,  
Shivam centrium, Sahar road,  
Koldongri, Andheri East,  
Mumbai, 400 069, India  
+ 91 22 6288 4200  
india@ocsial.com

### NORTH & SOUTH AMERICA

#### USA

950 Taylor Station Road,  
Suite #W, Gahanna,  
OH 43230, USA  
+1 415 906 5271  
usa@ocsial.com

### EUROPE

#### LUXEMBOURG

1 Rue de la Poudrerie,  
L-3364, Leudelange,  
Grand Duchy of Luxembourg  
+352 27990373  
europe@ocsial.com

tuball.com  
ocsial.com