

**Carbon Nanotubes:
New Markets and Developing Applications**
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Presented by

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1. Company profile: Nanocyl, S.A.

- a) History of the formation of Nanocyl
- b) Production capacity, and growth
- c) Product lines and services offered

2. Current technology and commercial applications for carbon nanotubes

- a) History of Nanotube technology
- b) Early successful applications

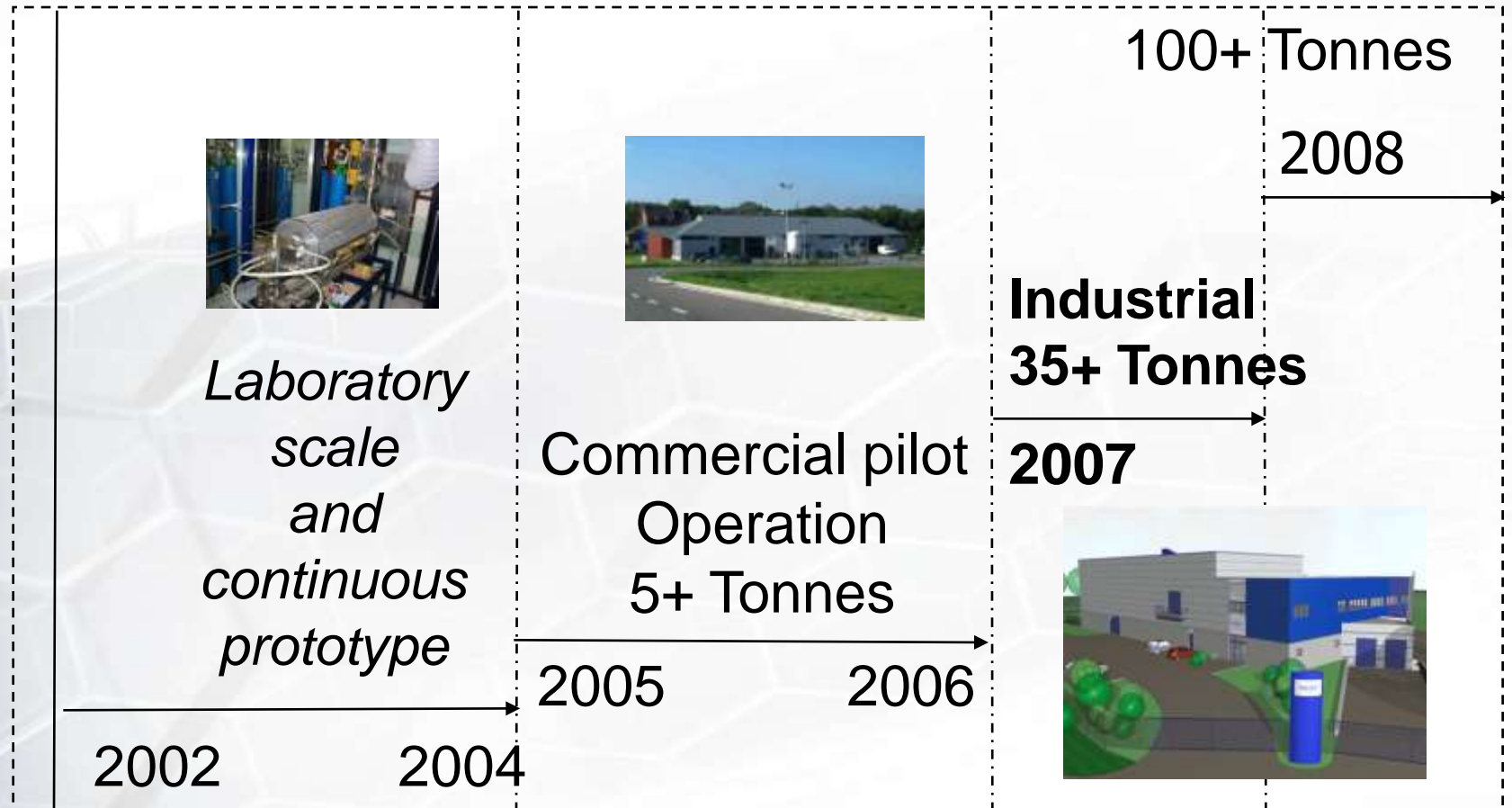
3. New (potentially commercial) applications for CNTs based on newer research



- 1999-2002; Preliminary research done at CRIF and University of Liege in Belgium
- Founded in 2002
- Privately owned (consortium of investors)
- >30 qualified employees
- Manufacturing and headquarters in Belgium, sales offices USA (Boston, MA), China (Shanghai)

- Agents & distributors: Cornelius (UK), Velox (EU), Nanobest & Shinjin (S. Korea), Mitsui Bussan (Japan)
- International research support and technology transfer
- One of the world's largest carbon nanotube production facilities (Sambreville, Belgium)
- The first ISO 9000 Certified supplier of both multi-wall and double-wall carbon nanotubes in the world

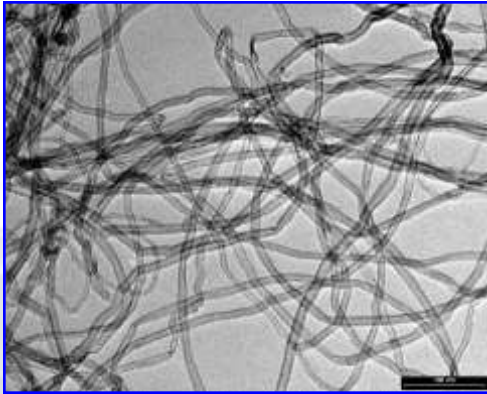
Capacity



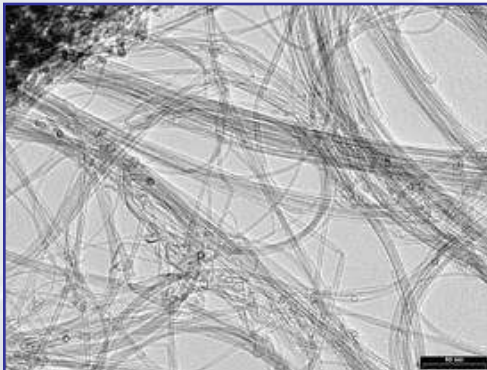
Products line

Line	Grades	Description
Industrial products	Nanocyl ® 7000	Carbon nanotubes powder, multi-uses (tons scale capacity)
	PlastiCyl™ PA 2001, PC 1501	Thermoplastic masterbatches (tons scale capacity)
Research grades	Nanocyl ® 1100, 2100, 3100 and 9000 series	Available in small quantities (1- several Kg) – Academic uses and R&D
Dispersions		
	EpoCyl™ BPA -MR01, EC01 AquaCyl™ AQ0101	Epoxy and aqueous dispersion - sampling stage (several Kg or liters)

Products line



Nanocyl® 7000/3100
Thin Multi-wall CNT
D: 9.5 nm L = 1.5 micron
NC7000 C purity = 90%
NC3100 C purity = 95+%
BET : 300 m²/g

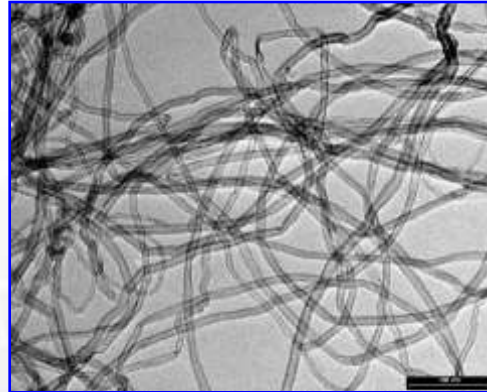
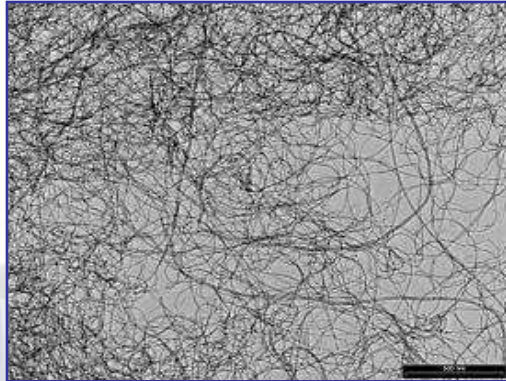


Nanocyl® 2100
Double Wall CNT
D: 3.5 nm L = several microns
C Purity 90+%
BET : 550 m²/g

Product development customer service

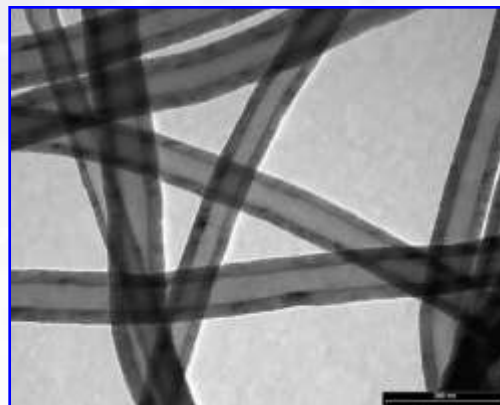
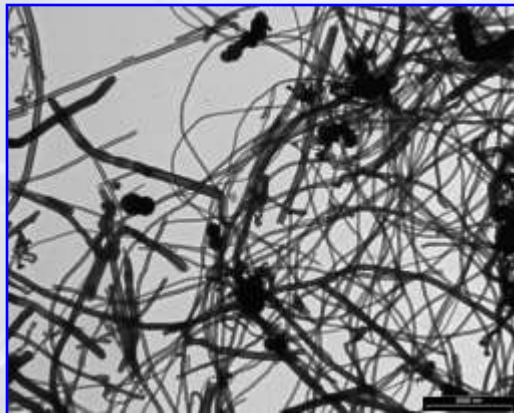
- Quick assessment of material properties and economic feasibility
 - » Determination of optimal loading
 - » Mechanical and electrical properties
 - » Thermoplastics, elastomers and thermosets
 - » Molded samples and films
- Fabrication of dispersions and masterbatches
 - » Pilot commercial twin-screw extruder
 - » Mixers for inks and liquid thermosets
- Compounding partners and associated laboratories
 - » University laboratories in BE, EU, and US
 - » Government laboratories in EU and US
 - » Strategic corporate partners with specific needs and/or technical expertise

CNT Technology



Nanocyl® 7000

Diameter = 9.5 nm



Nanofibers

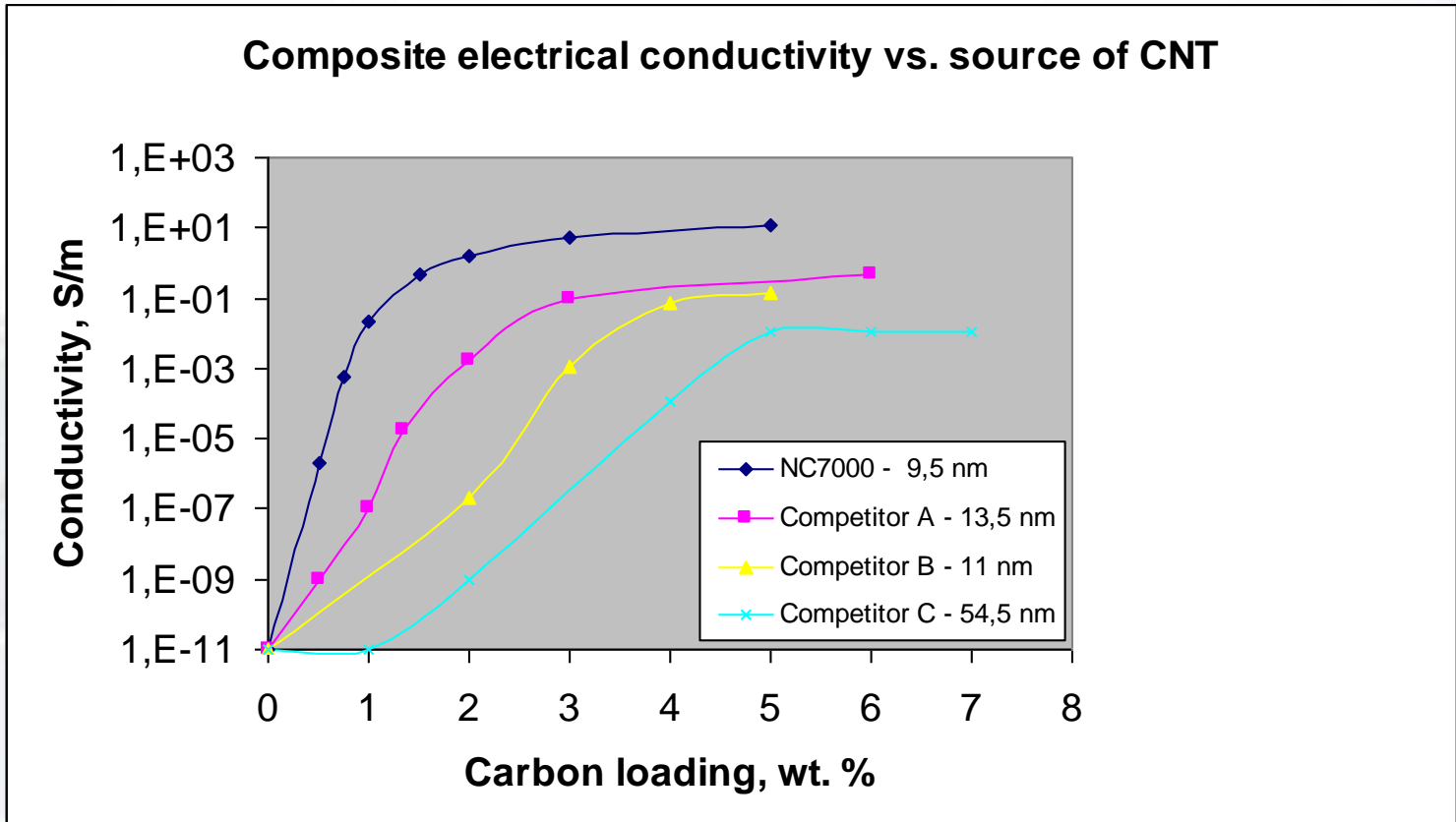
Diameter = 80 nm

- Electrostatic Dissipation (ESD)
 - » Automotive fuel systems - **Commercial**
 - » Electronics manufacturing & packaging - **Commercial**
 - » Electrical & Chemical Engineering parts - *Soon*
- Electrostatic painting
 - » Automotive and Motorcycle parts - **Commercial**
 - » Industrial ESD primer
- Structural composites
 - » Sporting goods - **Soon**
 - » Advanced elastomers - **Soon**

Automotive fuel systems parts



- Global commercial volume for Nanocyl
 - » 35 tons per year in 2007
 - » 50-100 tons per year in 2008
 - » Capacity to expand production
- Applications
 - » ESD and conductive plastics & resins (all CNT types)
 - » Batteries and Fuel Cell components
 - » Structural composites (DWCNTs)
 - » Anti-ballistic applications
- In-Situ CNT Growth potential
 - » Proven Strength characteristics
 - » Scale-up (potential) proven
 - » Needs further investment to “productionize”



NC7000 is the most conductive industrial MWNT Available today on the market

Nanocyl® 7000 vs. CF and CB

	NC7000	Milled & chopped carbon fibers	Conductive carbon black
Loading, wt.%	1.5 - 3	8 -12	8 -18
Market area of interest	Various Auto and electronics	Electronics packaging & handling	Automotive

Pure substitution of other conductive carbon additives in engineering plastics will be possible with current price & capacity development –
Benefits: better mechanical properties, easier processing and design, lighter materials ⇒ **lower cost**

New applications for Nanocyl® CNT

- Specialty films, coatings and adhesives
 - Conductive coatings & paints
 - Antistatic transparent films
 - Conductive & antistatic hot-melt adhesives
 - Conductive paper
- New applications
 - Fire-resistant paints
 - Anti-ballistic films
 - Antifouling paints
 - Thermal management fluids
 - Wave absorbing materials
 - Light sources

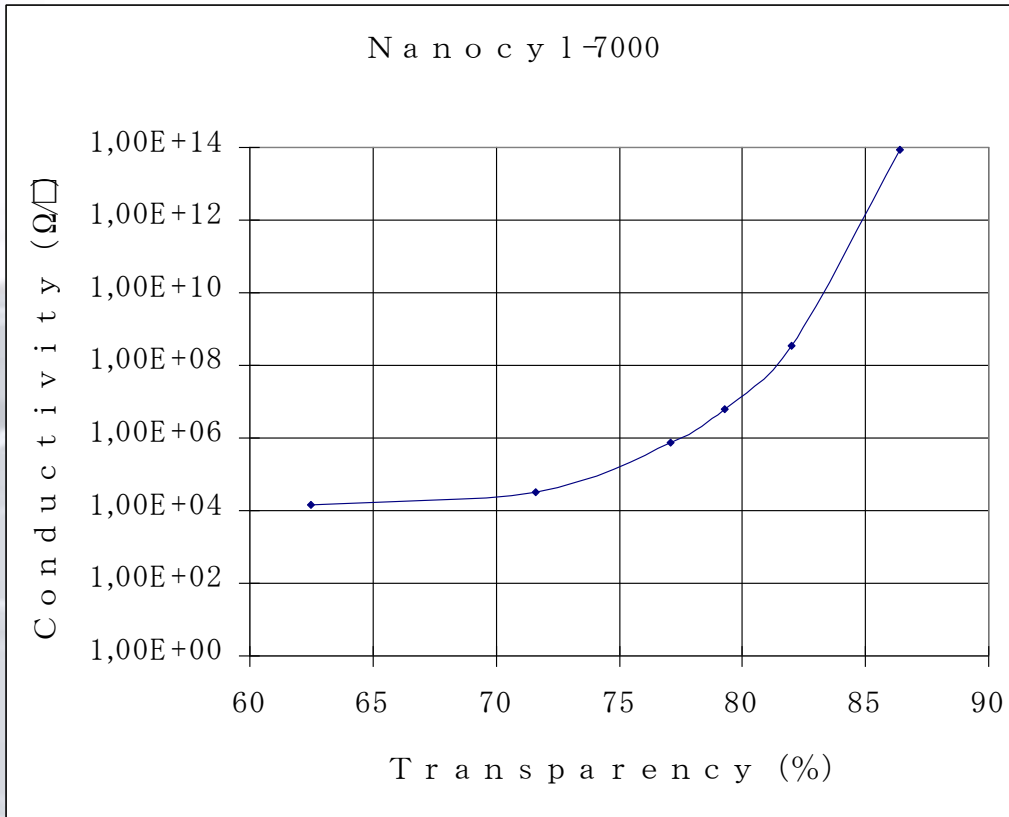
Newer application for Nanocyl® CNT

- Antistatic transparent paint & film (electronics packaging, glass,...)



Courtesy of Daido Corp. and Sumita Nanotechnologies Inc.

- Antistatic transparent PET film



Film specifications:

Surf. Res. = 10^{6-7} Ohms

Transparency = 79-87%

Haze = 1 – 1.8

Advantages

vs.

alternatives (ATO, ICP)

=

+ Mechanical properties

+ Chemical resistance

+ Flexibility

- CNT paper resistor heating:



Applications: Car's mirrors de-icing - Commercial 2008, seat heating, ... ⇒ *Added-value: higher flexibility of design vs. metal, high uniformity of temperature*

Carbon nanotubes as flame retardants Power cables, textiles and coatings

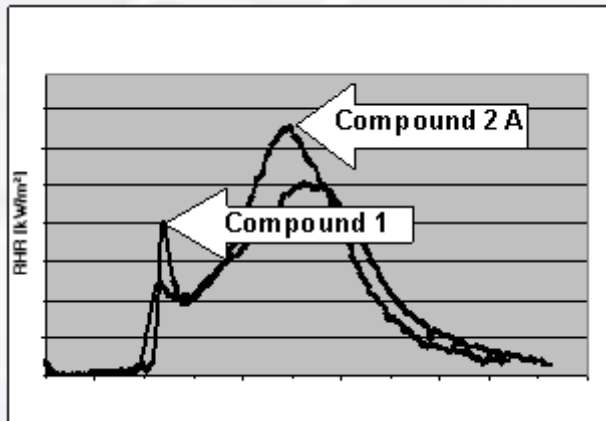


Thermal barrier coating

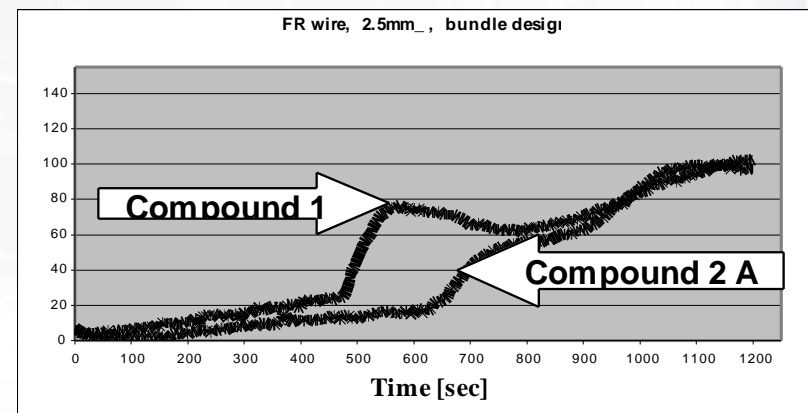
ISO 2685/ 1100°C / 116±10 kW/m²



IEC 60332-1 testing



Compound1= clays nanocomposite



Compound2A= clays/CNT nanocomposite

Nanocyl's production has increased by 700%. Pricing has dropped 25% to 40% in the past six months- This opens the market to many more automotive applications:

- Conductive SMC with thinner walls
- Conductive RIM for body panels
- Conductive TPE for bumper fascias
- Heat stability and UV resistant polymers for interiors (black)

Conclusions and Perspectives

- Nanocyl carbon nanotubes have been successfully integrated in several commercial applications, meeting cost and performance requirements
- CNT become more price competitive and might substitute for milled CF and high structure CB
- Unexpected properties of carbon nanotubes are going to open the market to more commercial applications

Thank you for your interest