

Smart WPC Seminar, Kokkola, 2019-09-11

**RI
SE**



**SMART
WPC**

POTENTIAL, STATUS,
CHALLENGE AND INSPIRATION
OF NANO-MODIFIED POLYMER
COMPOSITES

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2019-09-11

**Interreg
Nord**

Europeiska regionala utvecklingsfonden



EUROPEISKA UNIONEN



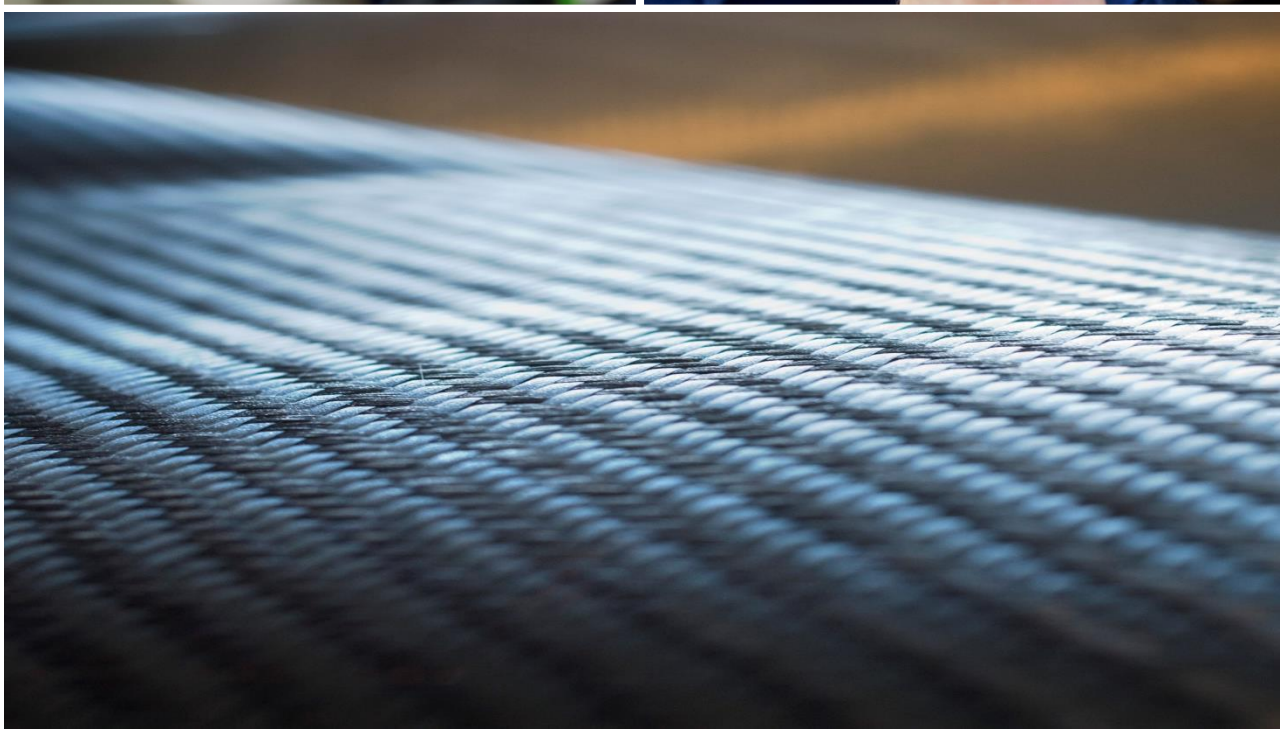
**REGION
NORRBOTTEN**



LAPIN LIITTO

Research Institutes of Sweden

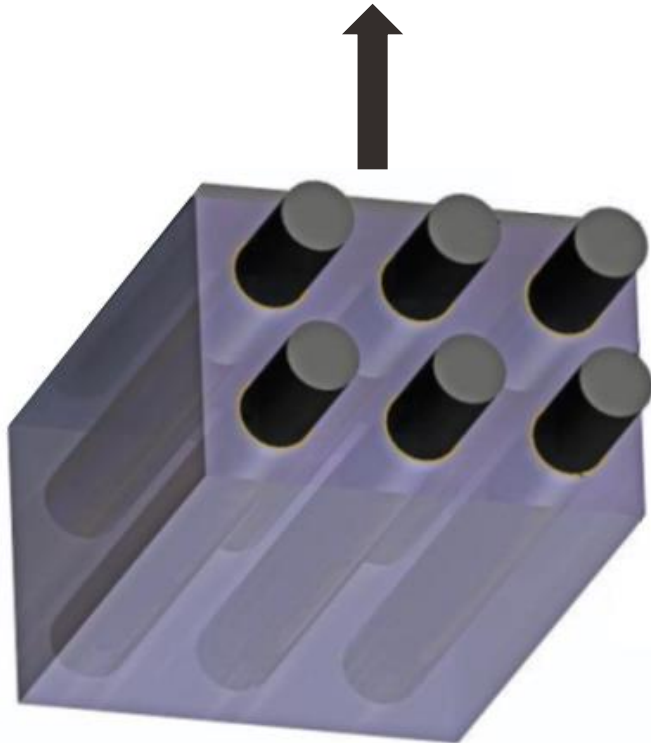
**Material and production
RISE SICOMP**



- What are the reasons for the development?
- What nanomaterials have been and are mostly used?
- What is the R&D and industrial application status?
- What is the development trend?
- What are the most commonly used methods for nano-integration and commonly met challenges?

Traditional fibre-reinforced polymer composite

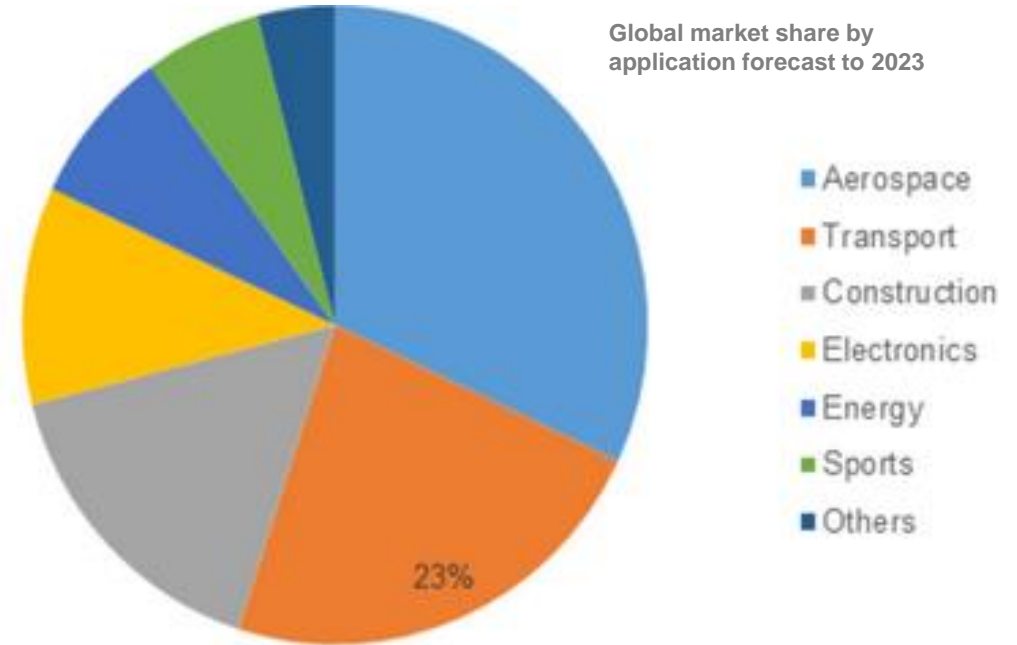
- excellent in-plane properties
- poor out-of-plan (through-thickness) properties
- polymer matrix-rich regions are the Achilles heel
- limited multifunctionalities



Advanced composite materials

- highly enhanced properties
- newly introduced functions
- tailored properties for specific needs

The market is projected to reach USD 38.41 billion by 2022 from USD 22.91 billion in 2017, at an annual growth rate of 10.89% from 2017 to 2022

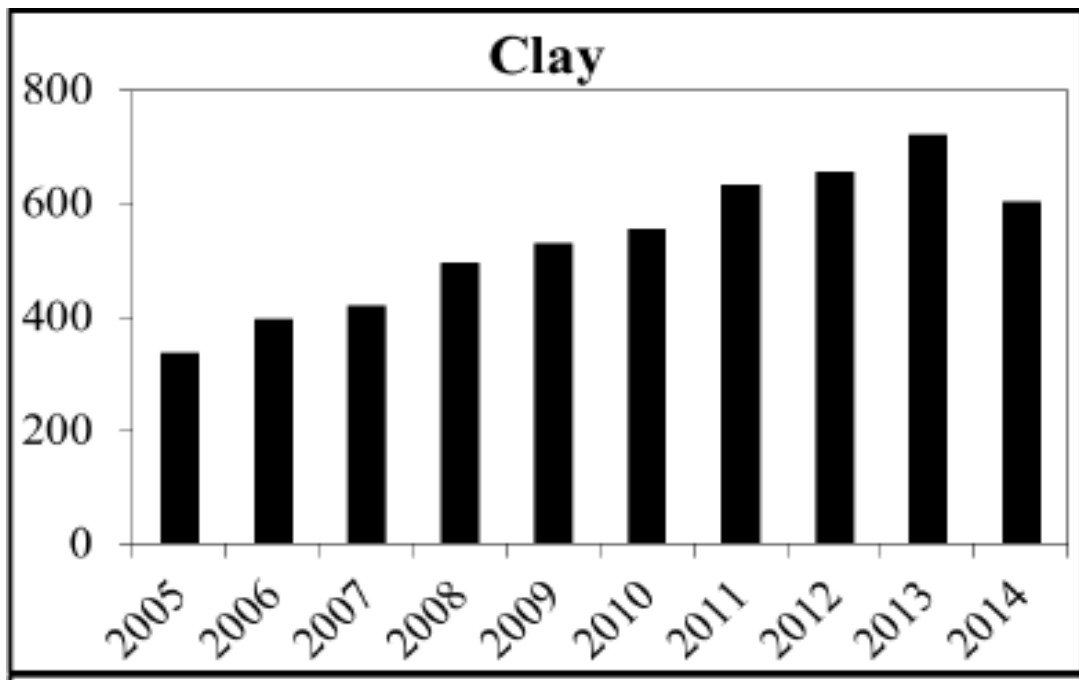


New technologies

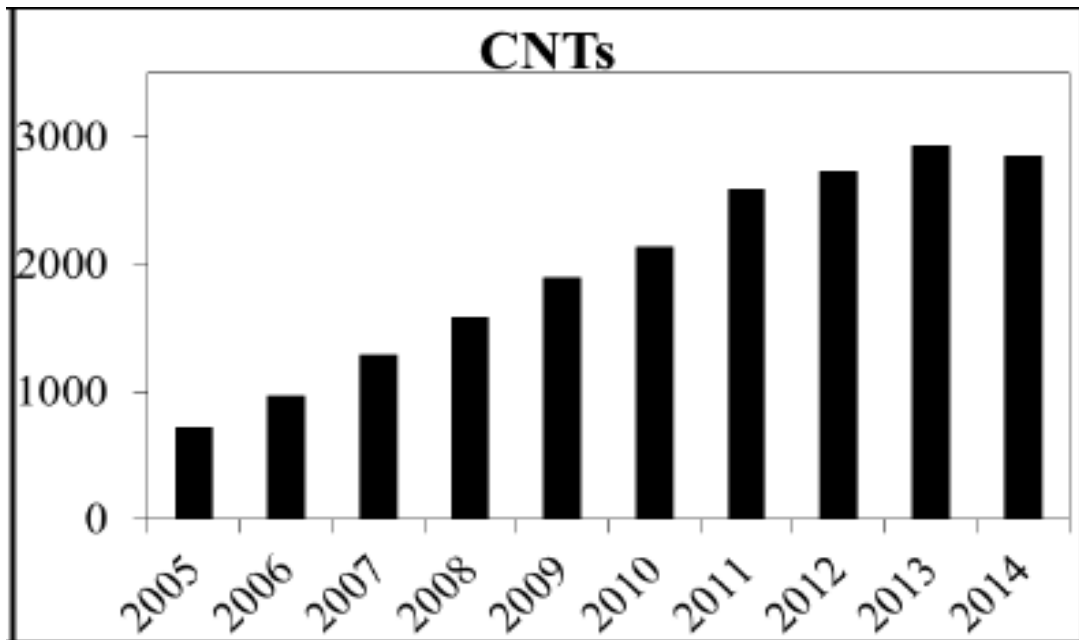
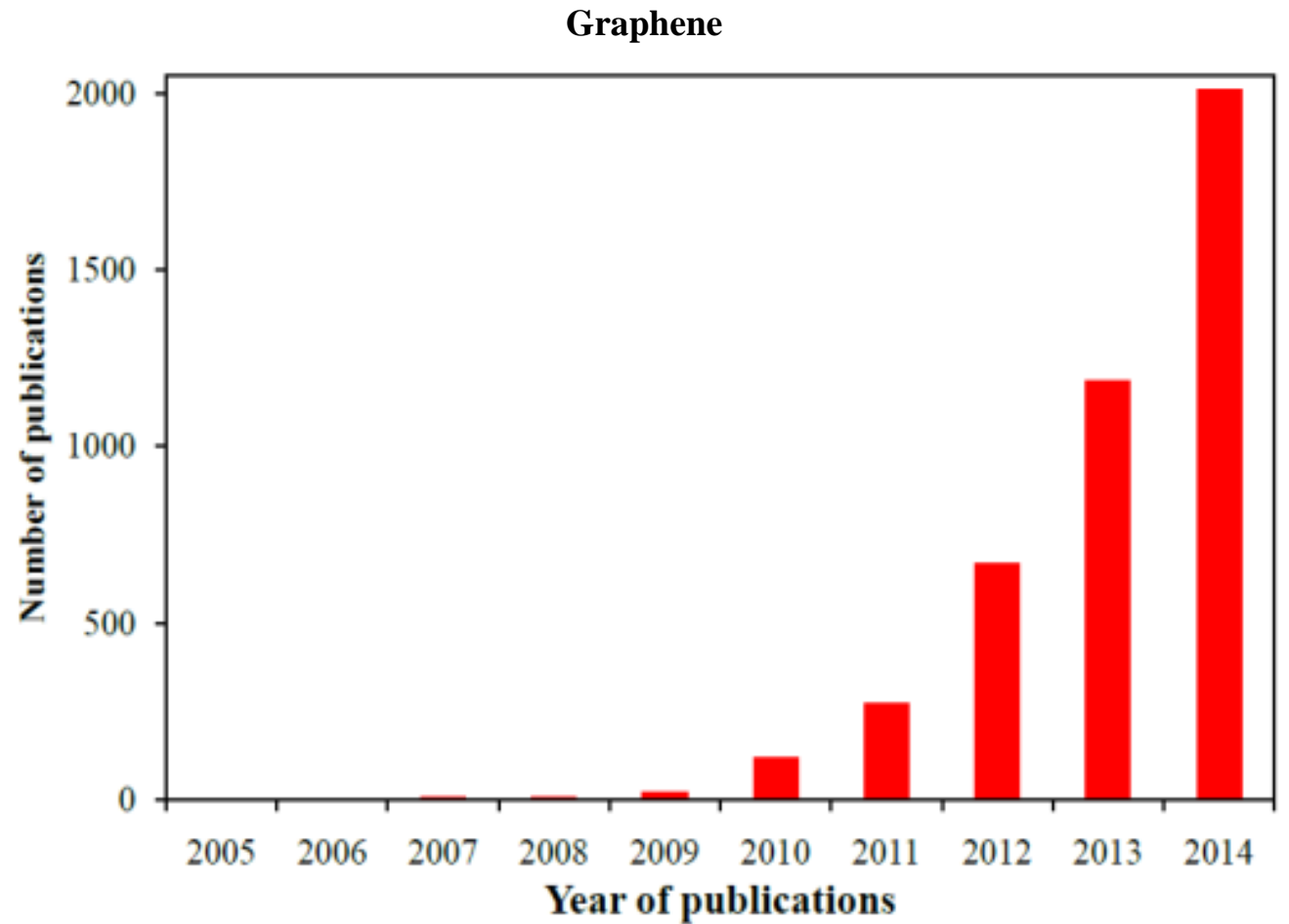
- materials
- processing & manufacturing
- characterization
- modelling

Nanotechnology

- ✓ To create revolutionary properties and functions by tailoring materials and designing devices on the nanometer scale

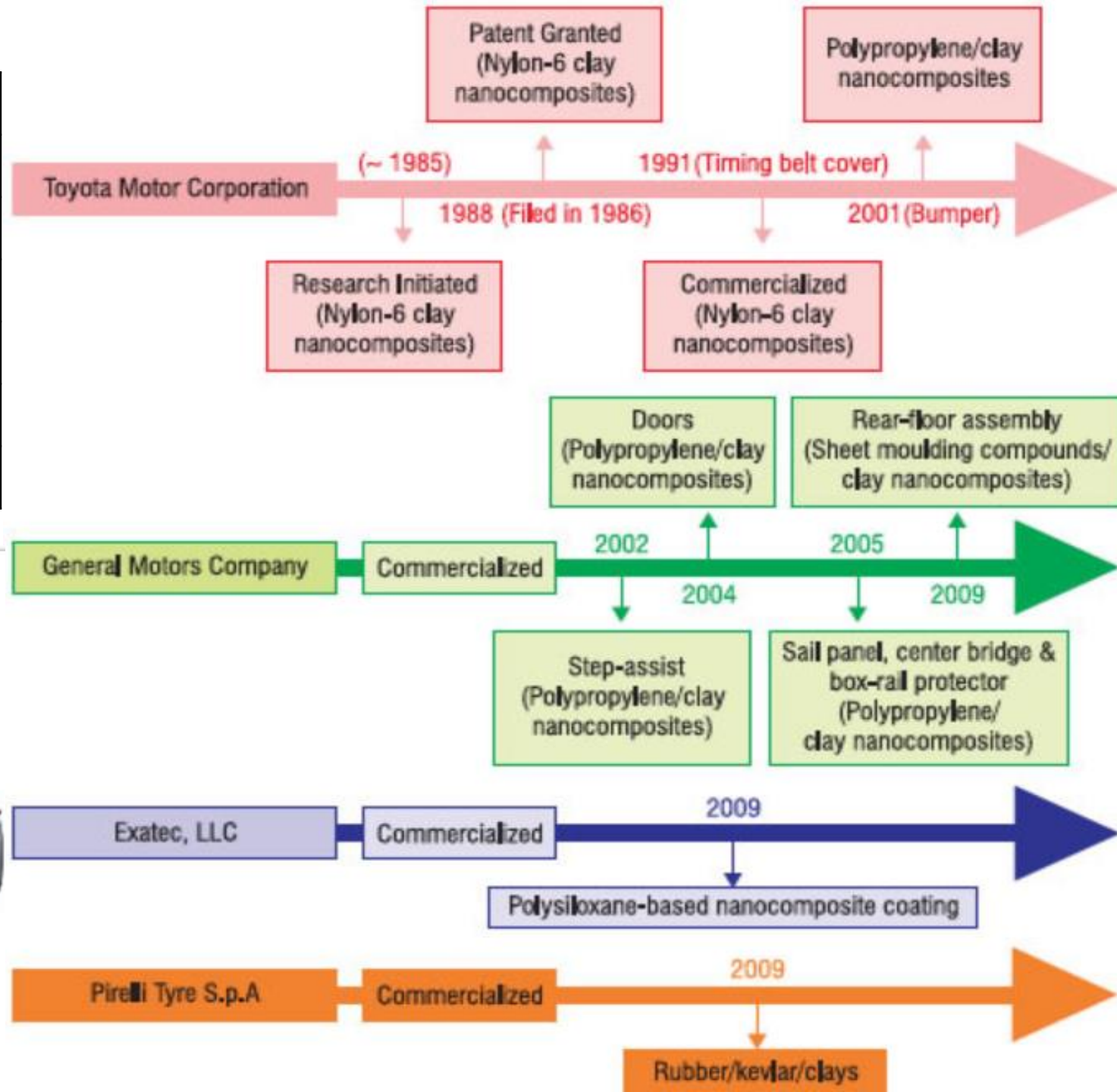
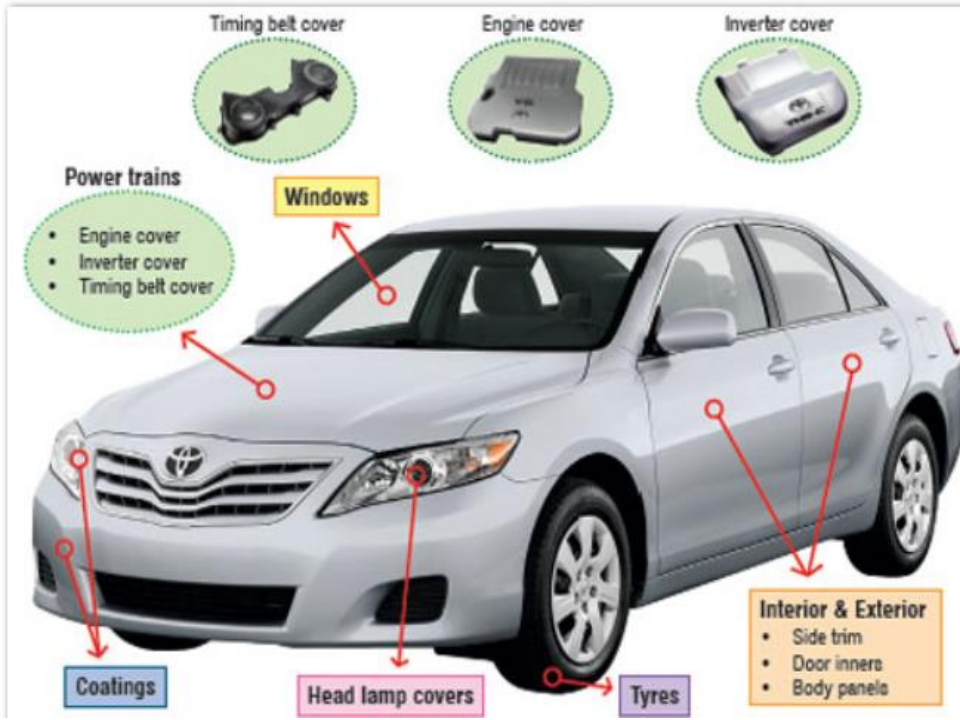


Number of yearly publications 2005-2014 (Thomson Reuters)



Nanoclay

	Nanoclay
Specific surface area (m ² /g)	~750
Aspect ratio	10-1000
Elastic modulus (GPa)	14-400
Tensile strength (GPa)	
Thermal conductivity (W/mK) at RT	
Electrical conductivity (S/m)	



CNT

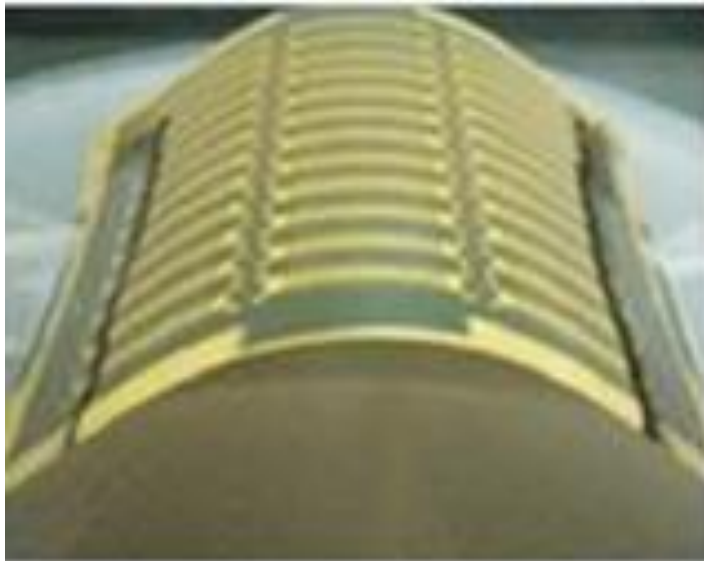
	CNT
Specific surface area (m ² /g)	50-1315
Aspect ratio	> 1000
Elastic modulus (GPa)	200-1000
Tensile strength (GPa)	13-150
Thermal conductivity (W/mK) at RT	3500
Electrical conductivity (S/m)	3000-4000



Winning Tour de France bicycle uses CNT composite (2005)



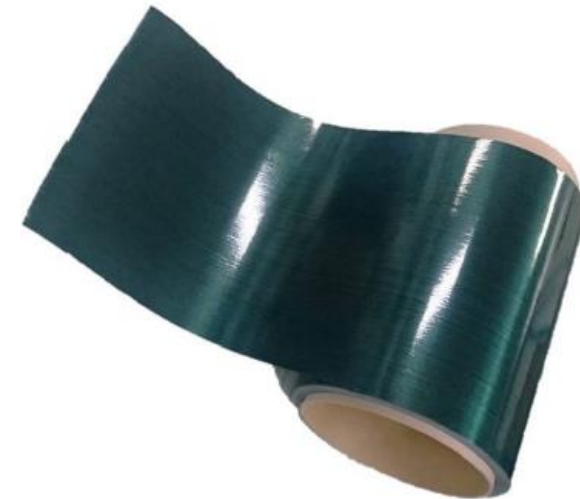
Ship hull coated with antifouling CNT paint (2008)



Painted CNT transistors on polymer film (2009)



Juno spacecraft uses CNT ESD shield (2011)



CNT-enhanced CFRP prepreg (high tensile properties and shock resistance) (Toho Tenax, 2018)

Graphene



	Graphene
Specific surface area (m ² /g)	2630
Aspect ratio	> 1000
Elastic modulus (GPa)	1000
Tensile strength (GPa)	~ 130
Thermal conductivity (W/mK) at RT	4800-5300
Electrical conductivity (S/m)	7200

Head (2013-2014): graphene-enhanced tennis rackets and skis



Vittoria (2014): graphene-enhanced composite materials for the world's fastest bicycle wheels



Catlike (2014-20105): graphene-enhanced cycling helmets and shoes

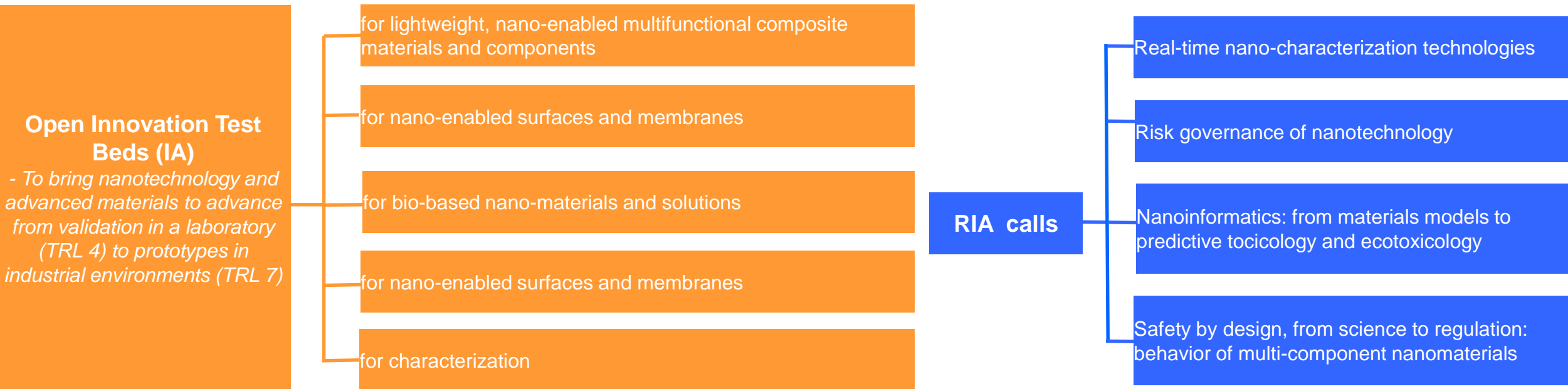
BAC & Haydale – graphene enhanced CF for rear arches
 Haydale - graphene enhanced prepreg and CF composite rear wheel arch (JEC World 2018)



Briggs Automotive Company (2016): single-seater Mono sports car using graphene-enhanced resin in bodywork

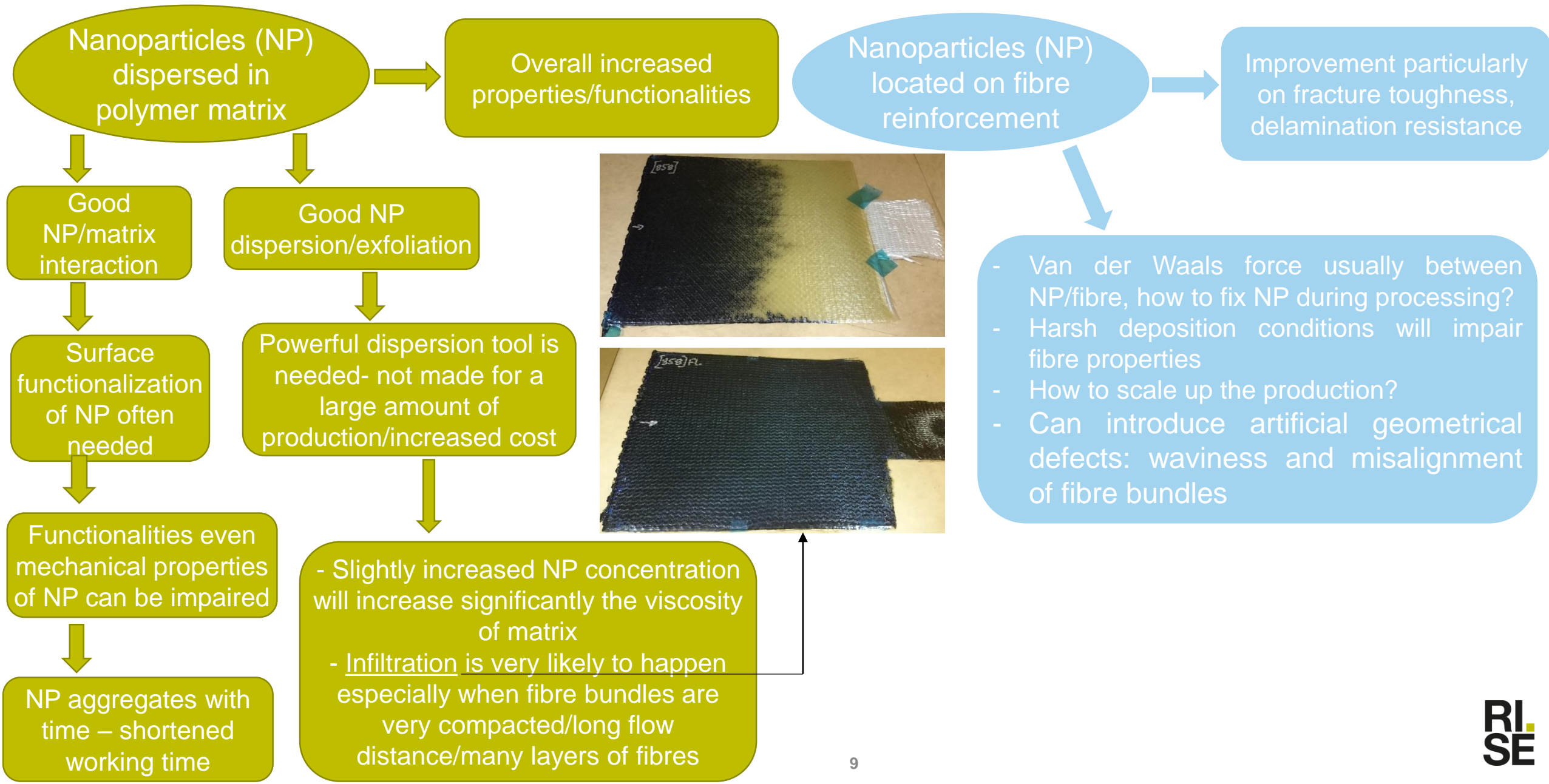
HORIZON 2020 (2014-2020): Framework Programme for Research and Technological Development from European Commission

- In the last batch of calls or coming calls for *Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing (NMBP)*

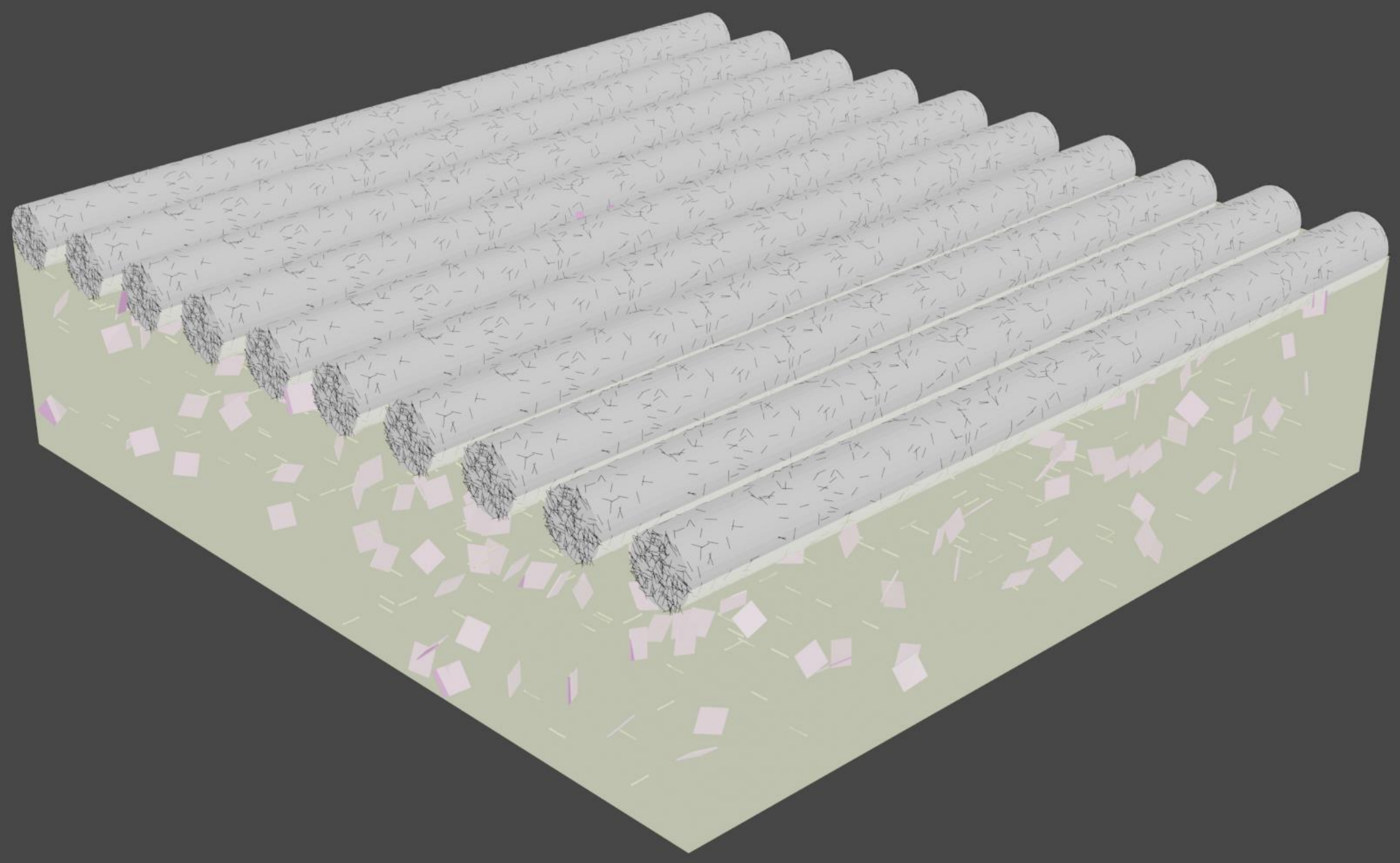


- Current challenge to overcome is to reduce the material and processing costs by finding applications where the nanomaterials can make significant impact on composite material performance, in addition to enhanced safety control & sustainability and reduced environmental impact

What can be the practical challenges when processing nano-modified FRP?



Smart WPC Concept



Summary

- Integration of nano-materials into FRP composites is a potential way to achieve advanced composites with lighter weight, higher performance and multifunctionalities relative to traditional FRP composites
- The technologies of processing and manufacturing need to be tailored for required properties
- Industrial demand is a very important driving force behind the development of related knowledge and technology

Acknowledgement



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