

**TYRE RECYCLING SOLUTIONS SA**

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# **INNOVATIVE TIRE RECYCLING TECHNOLOGIES**



## **PEOPLE SEE WASTE**

- **Globally, material recovery less than 50% of waste tire recovery**

## **WE SEE OPPORTUNITY**

- **Tyre Recycling Solutions SA is a Swiss Cleantech and Specialty Materials company. It has developed a toolbox of technologies and know-how to manufacture performance rubber powders from end-of-life tires.**

# OUR LOCATIONS



TRS licenses its technology worldwide

In **2020**, our Chinese partner company will  
establish the first production plant in **China**

# INTEGRATED SOLUTIONS

TREATING 100% OF THE WASTE TIRE

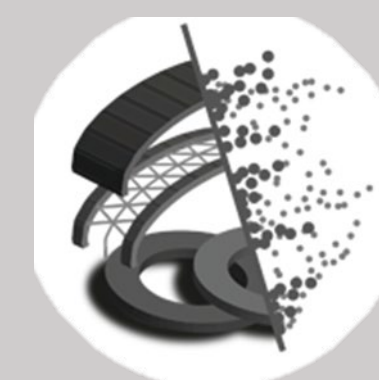
TECHNOLOGIES:



trs t-cut™



trs Water Pulse™



Micro Granulation

INTELLIGENT  
COMPOUNDING:



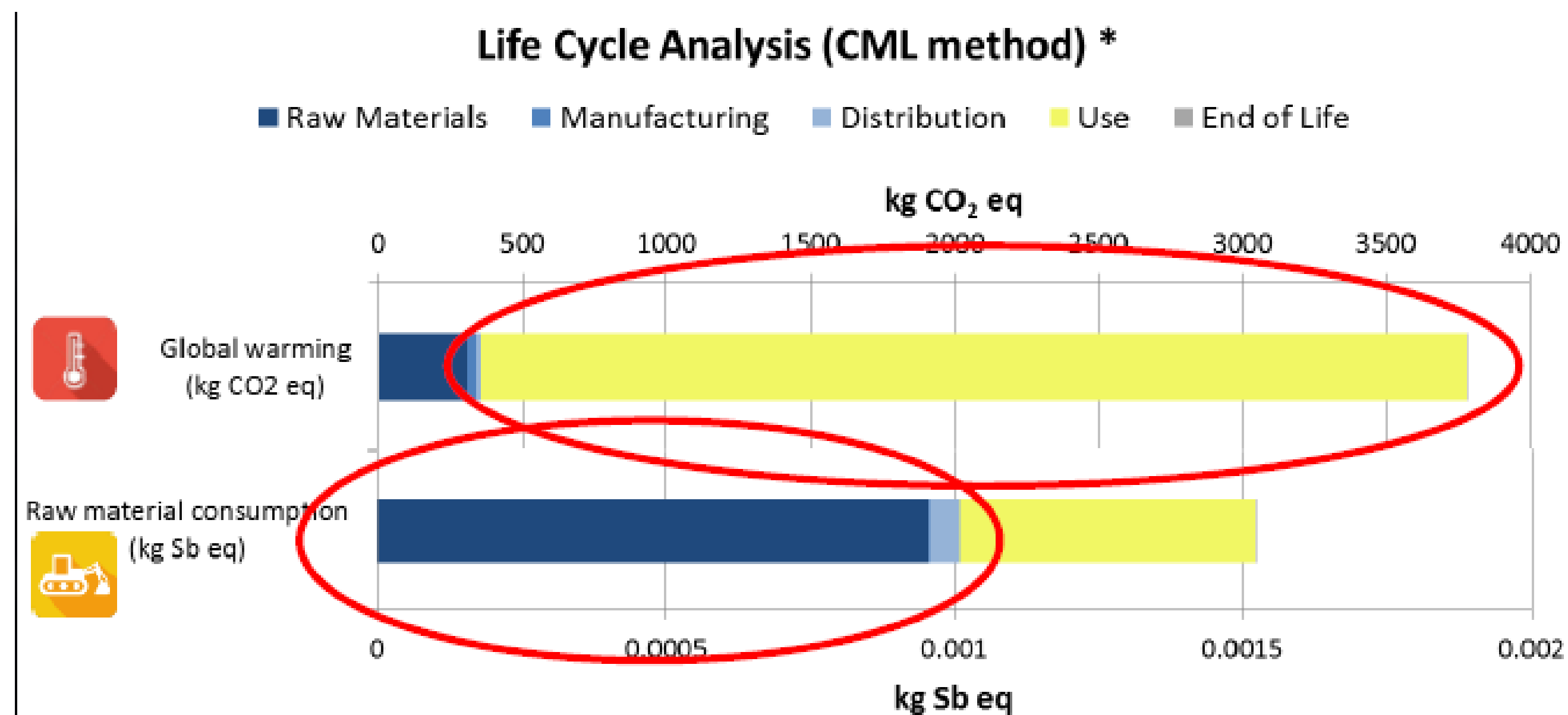
High quality rubber powders treated and further transformed using **trs BioDevulc™** or **trs Chemical Activation**.

# TIRE INDUSTRY: IMPROVING ENVIRONMENTAL FOOTPRINT

The challenge:

- **1950: 50 mio vehicles**
- **2000: 800 Million**
- **2050: 2 Billion ?**

This trend will put more focus on material (re)use



\*For 150'000 km driven for an average European vehicle (source: Michelin)

# SUSTAINABILITY IS NOW PART OF THE STRATEGY



**By 2048:**  
**100% of tires recycled**  
**Tires made with 80% sustainable materials**



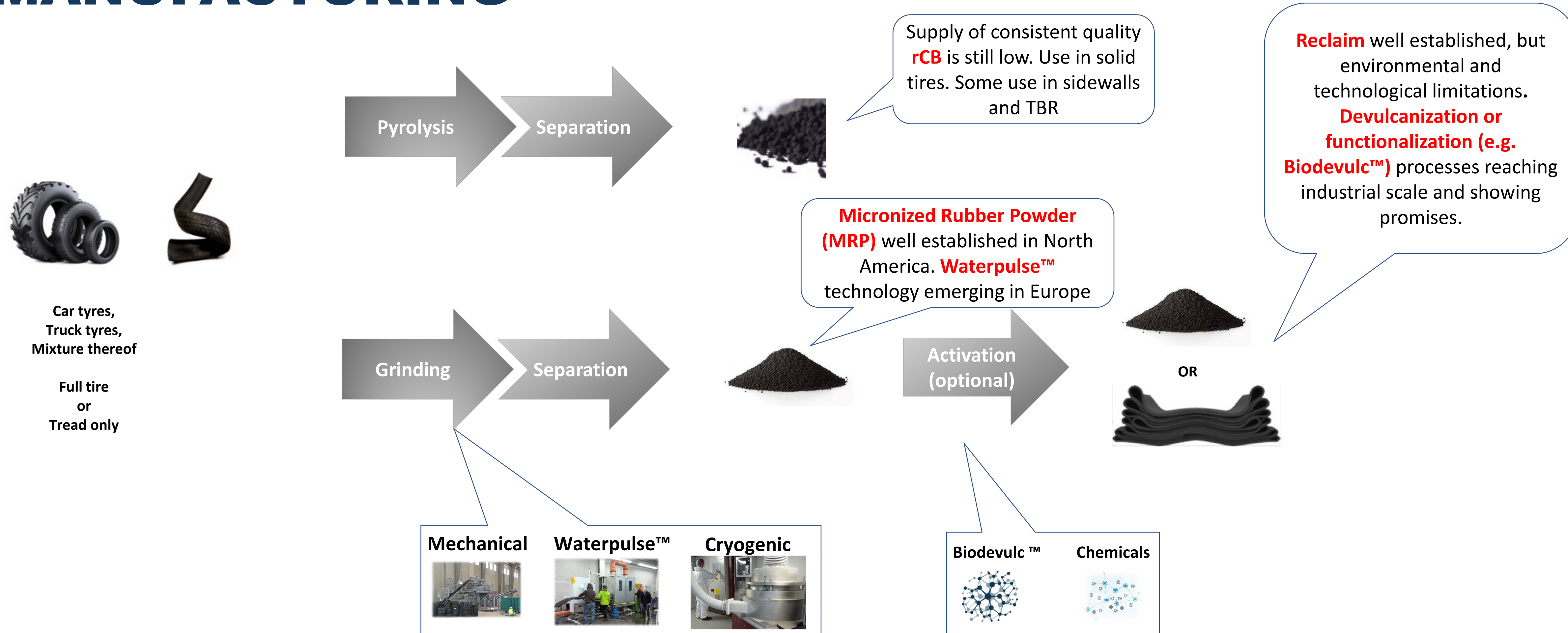
**10% Recycling by 2025**



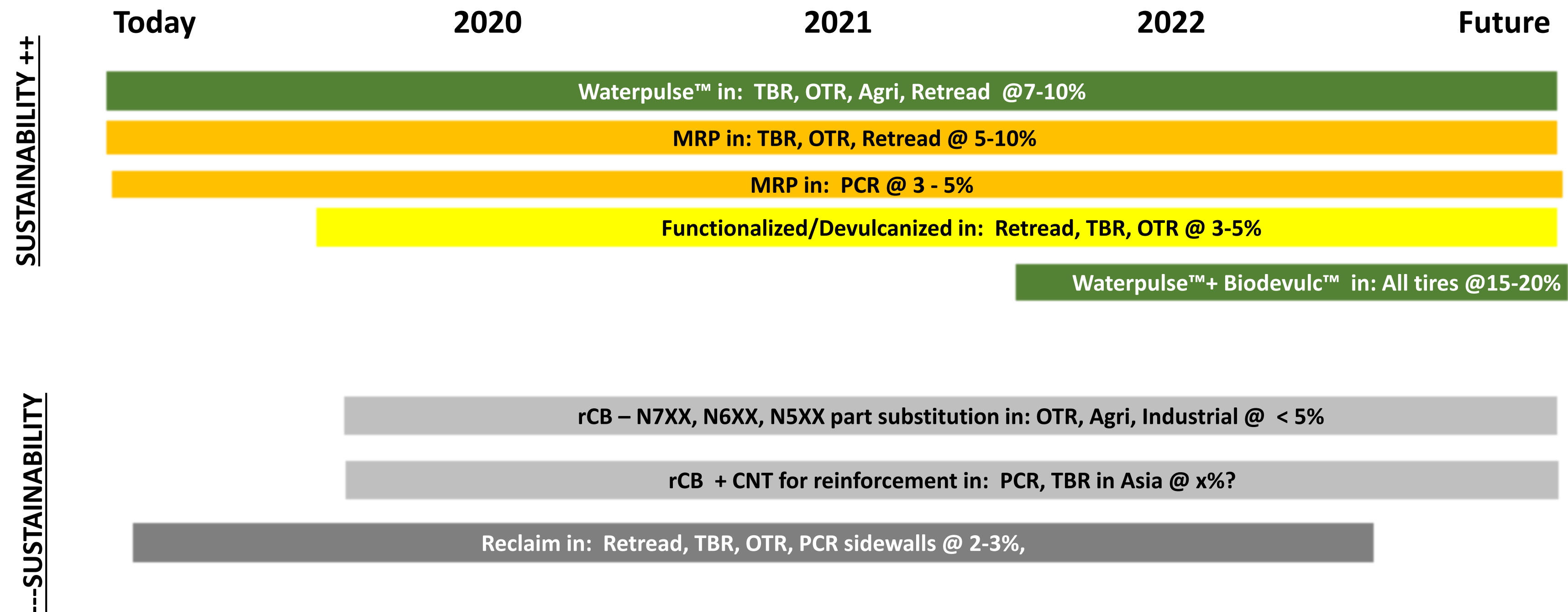
**By 2050:**  
**Tires made with 100% sustainable materials**

**.....What about China Tire producers?**

# TIRE RECYCLING MATERIALS FOR TIRE MANUFACTURING



# ROADMAP FOR MATERIAL USE IN TIRES



**COST SAVINGS DRAMATICALLY INCREASE WITH ADDITION LEVEL**

# waterpulse™

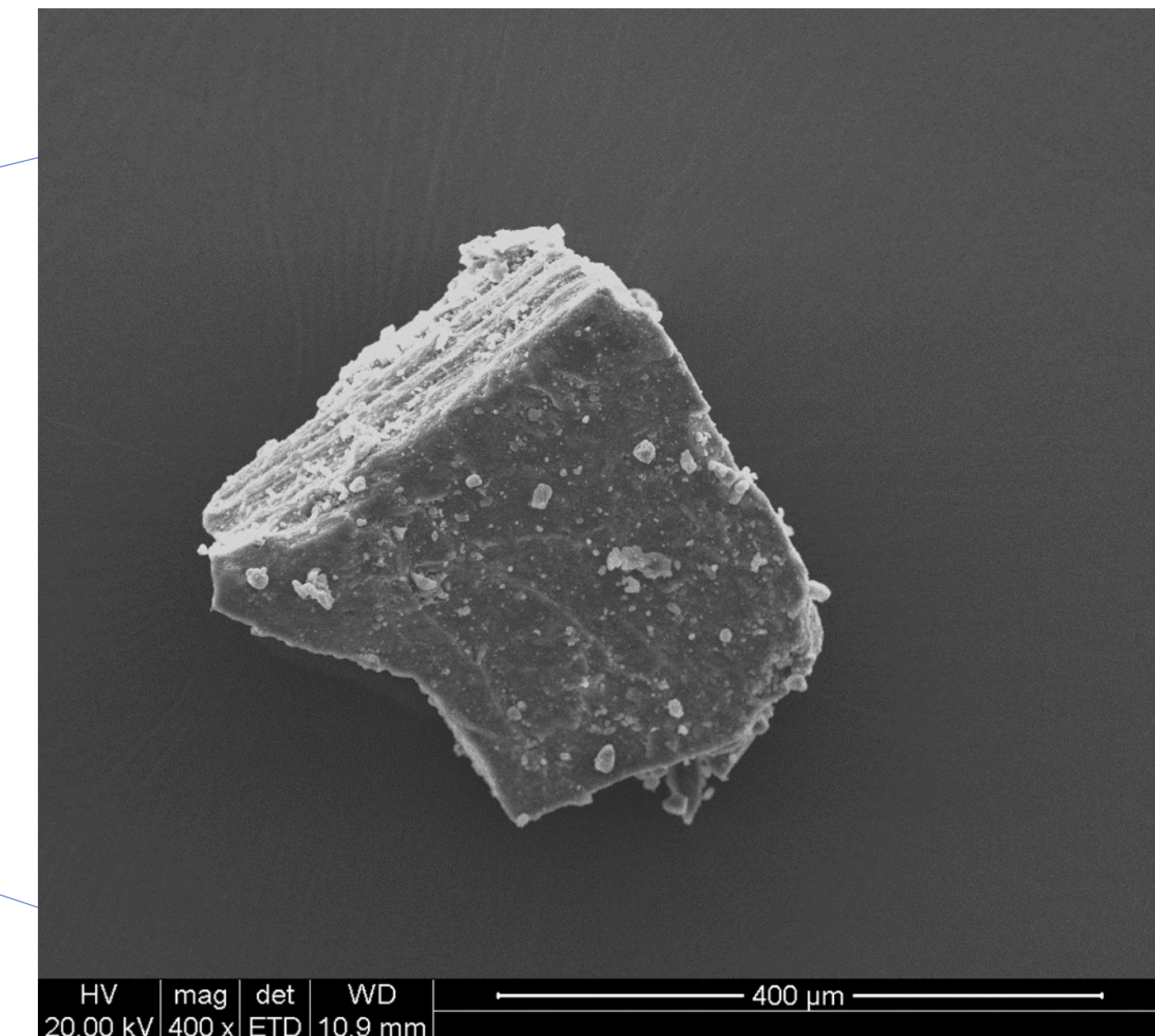
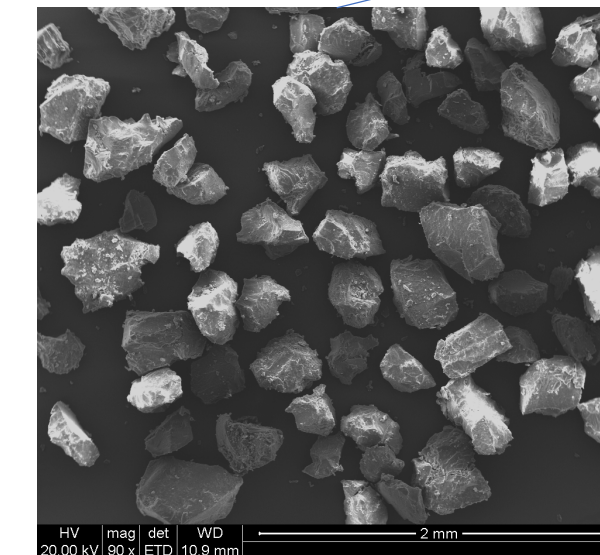
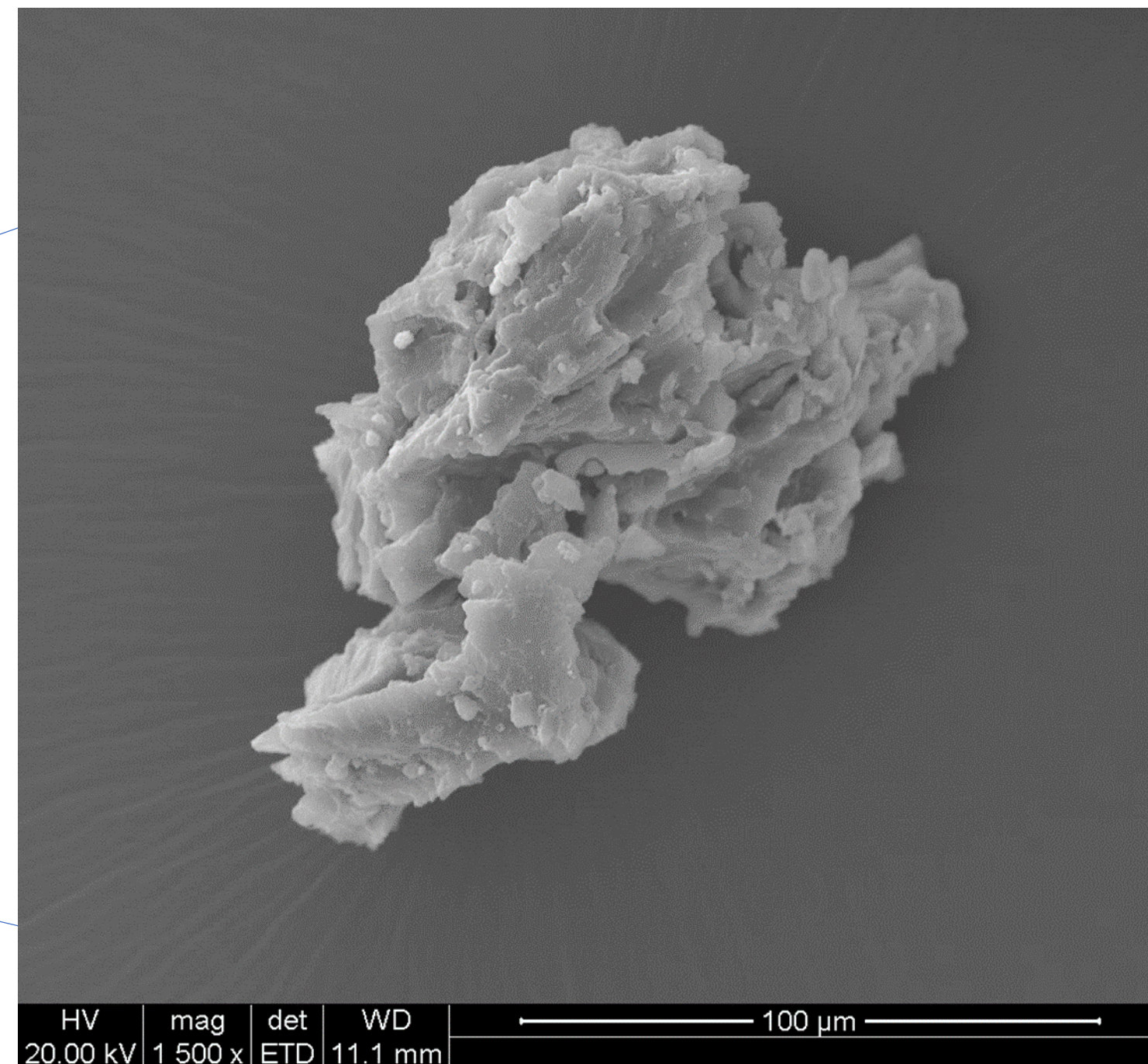
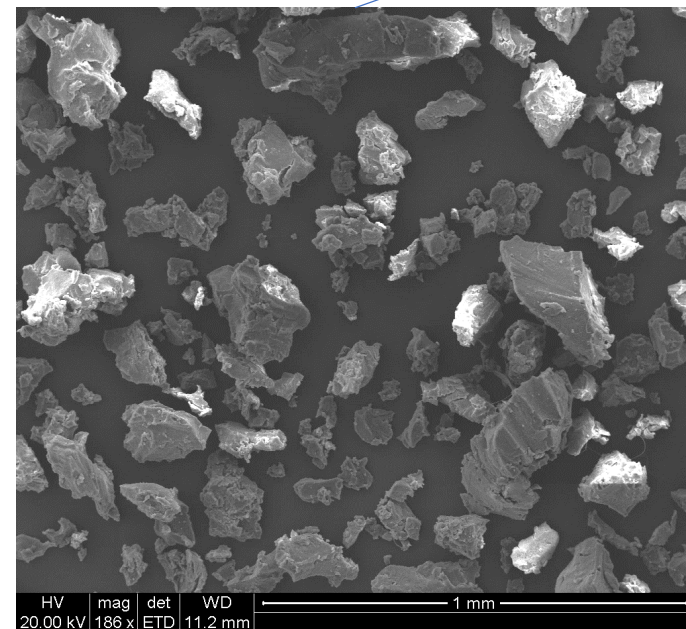
## TECHNOLOGY

- Rubber powder from (car) tread only – free of butyl rubber
- High surface area, enhanced bonding
- No heat involved in the process, no unwanted cleavage of polymer chains
- Free of fibers and steel
- Fine particles – two grades available
  - <600 microns (30 mesh)
  - <330 microns (50 mesh)



# Waterpulse™

## PARTICLE MORPHOLOGY



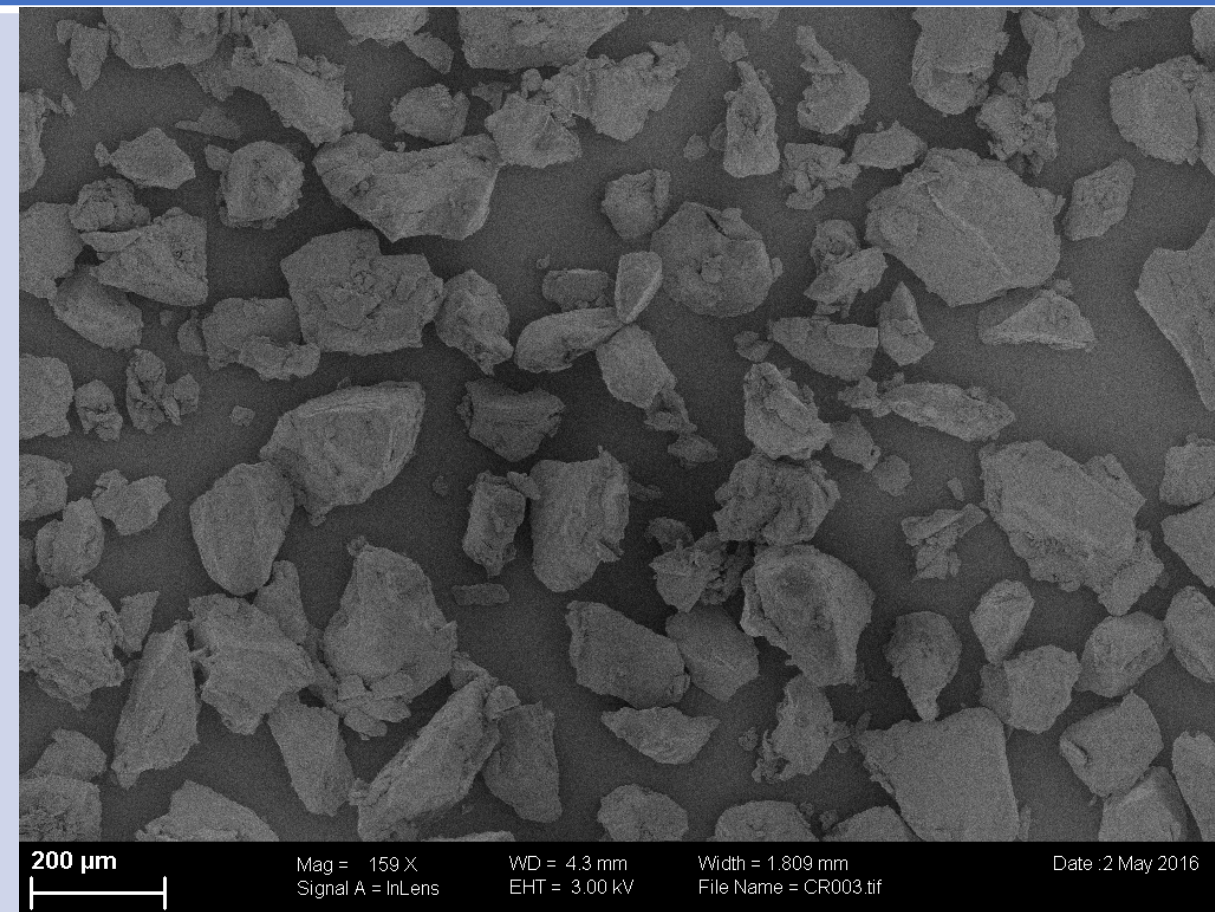
0-400μ SEM images of waterpulse(TM)  
rubber particles

50-400μ cryogenic powder

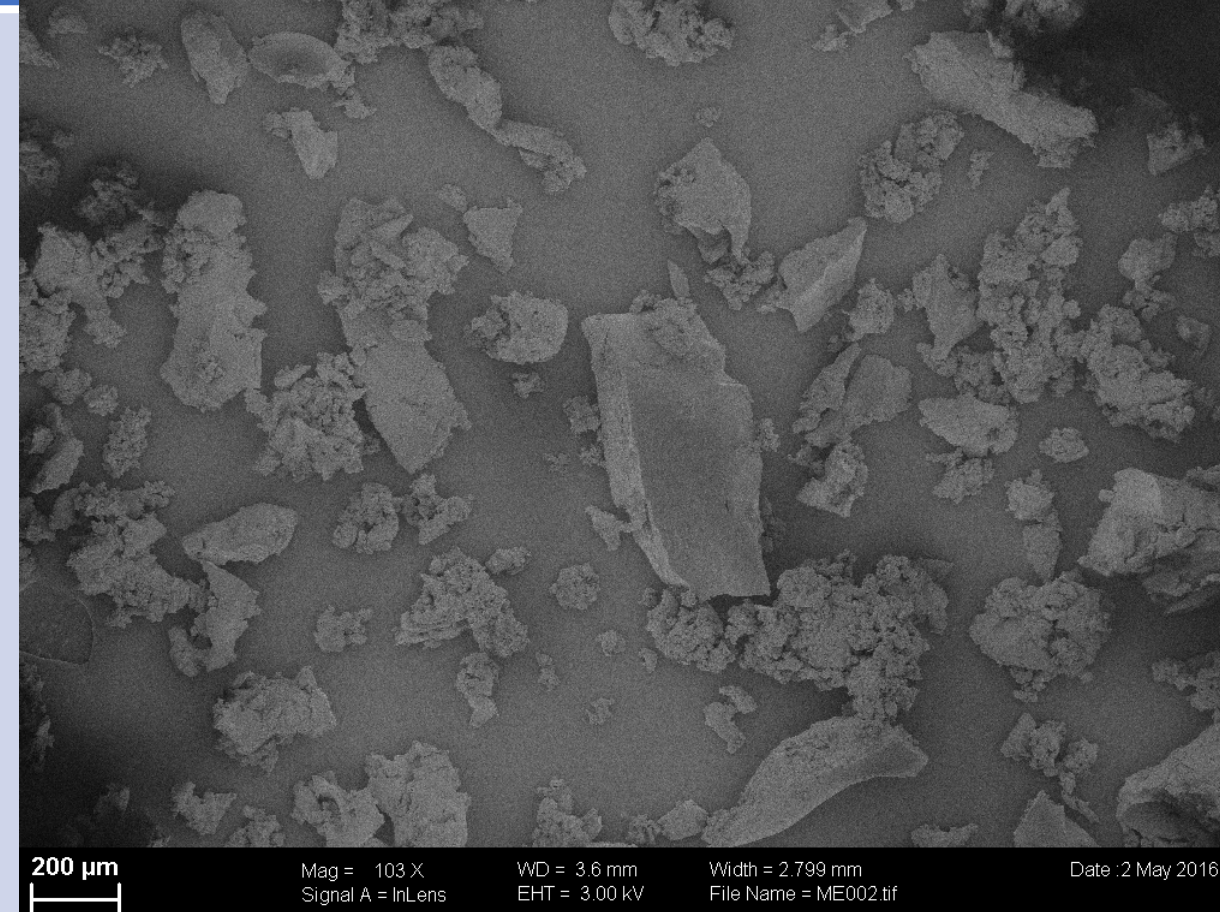
# Morphology – at comparable magnification

200  $\mu\text{m}$  magnification

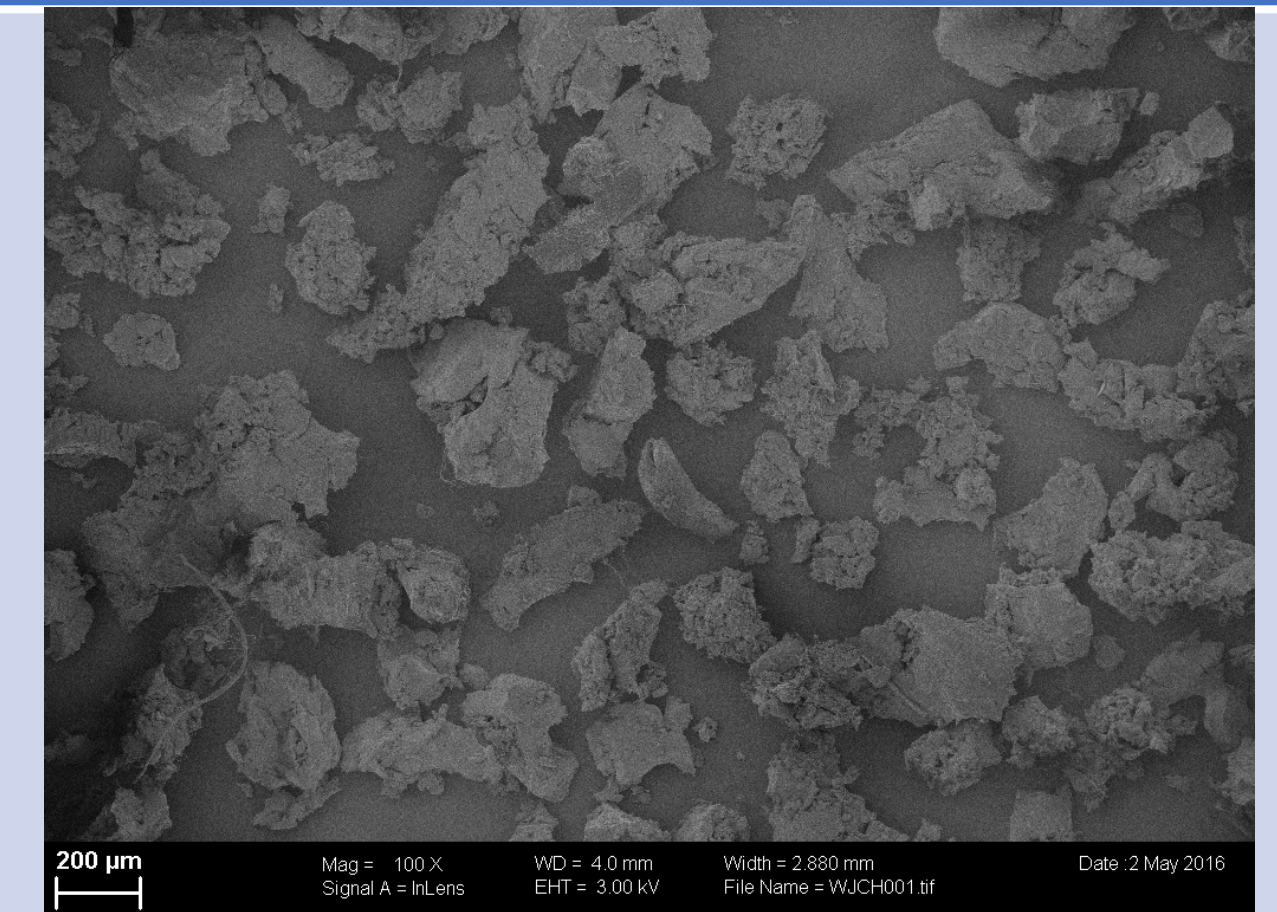
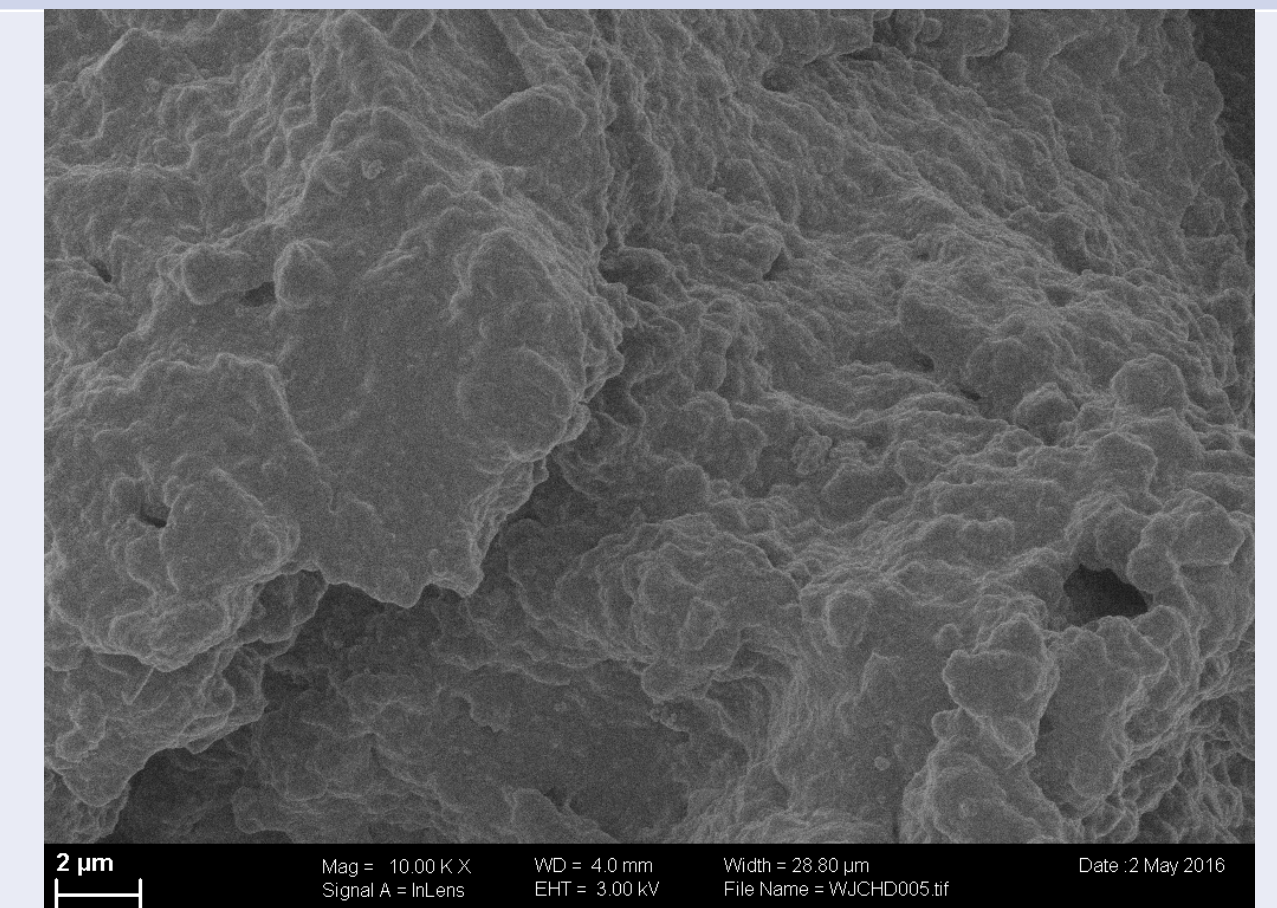
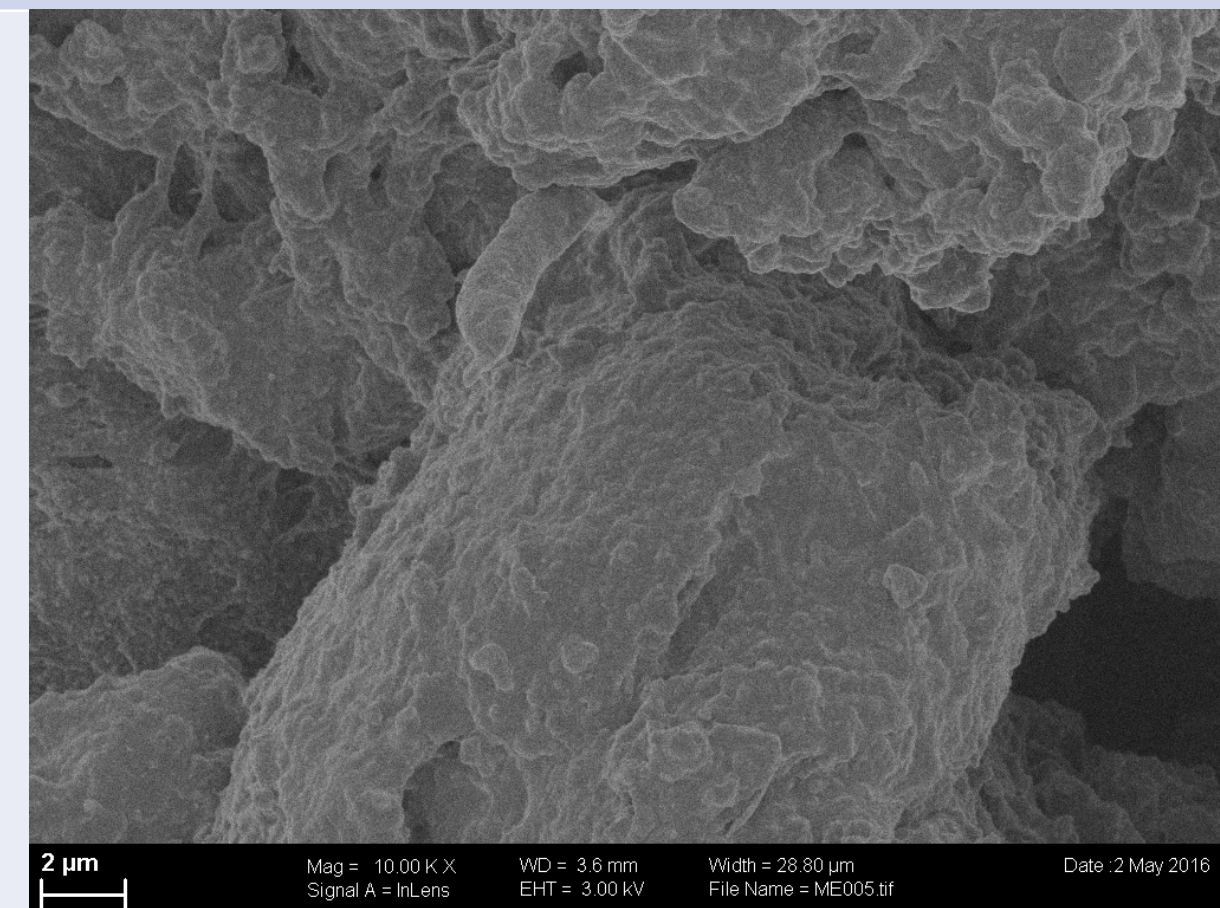
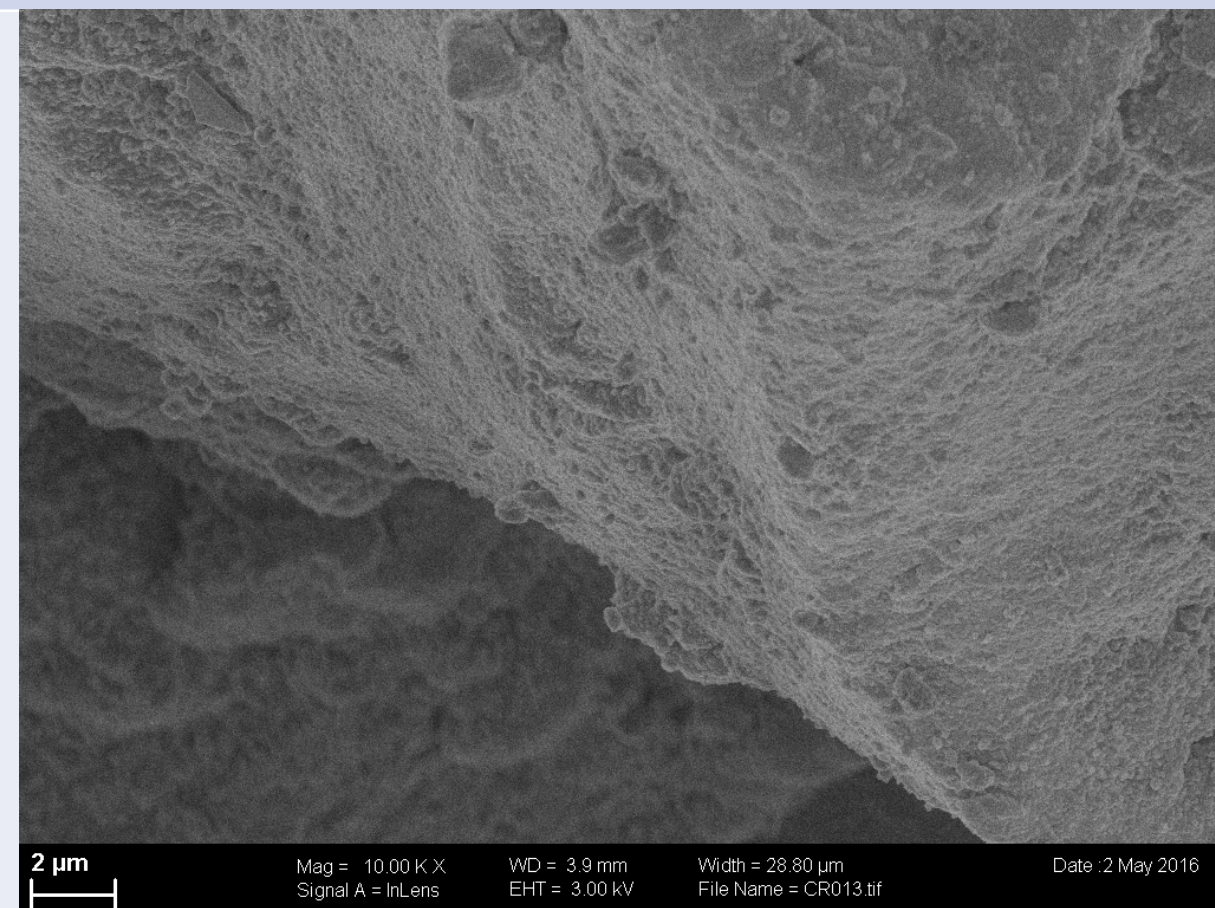
## Cryogenic



## Mechanical

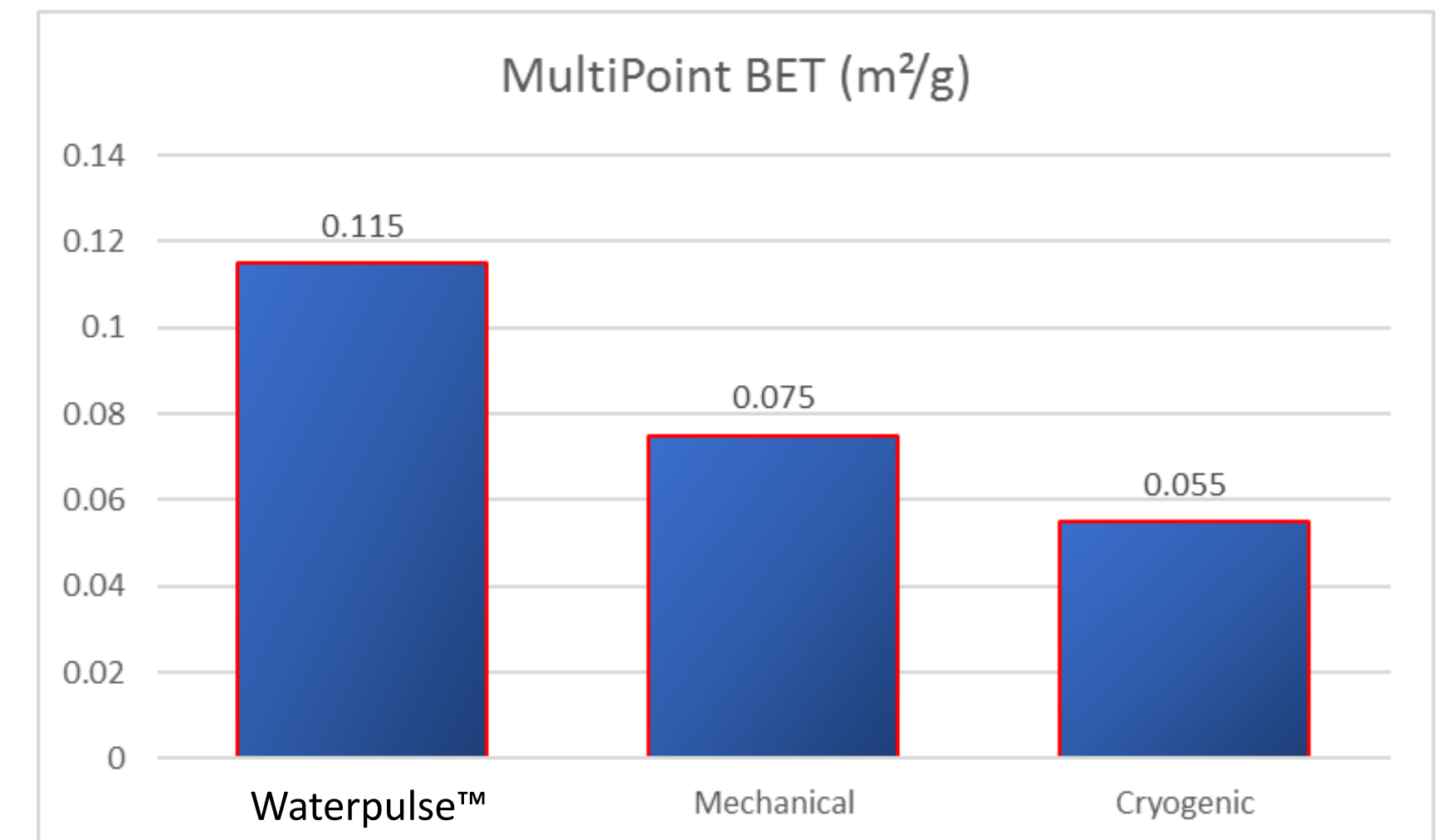
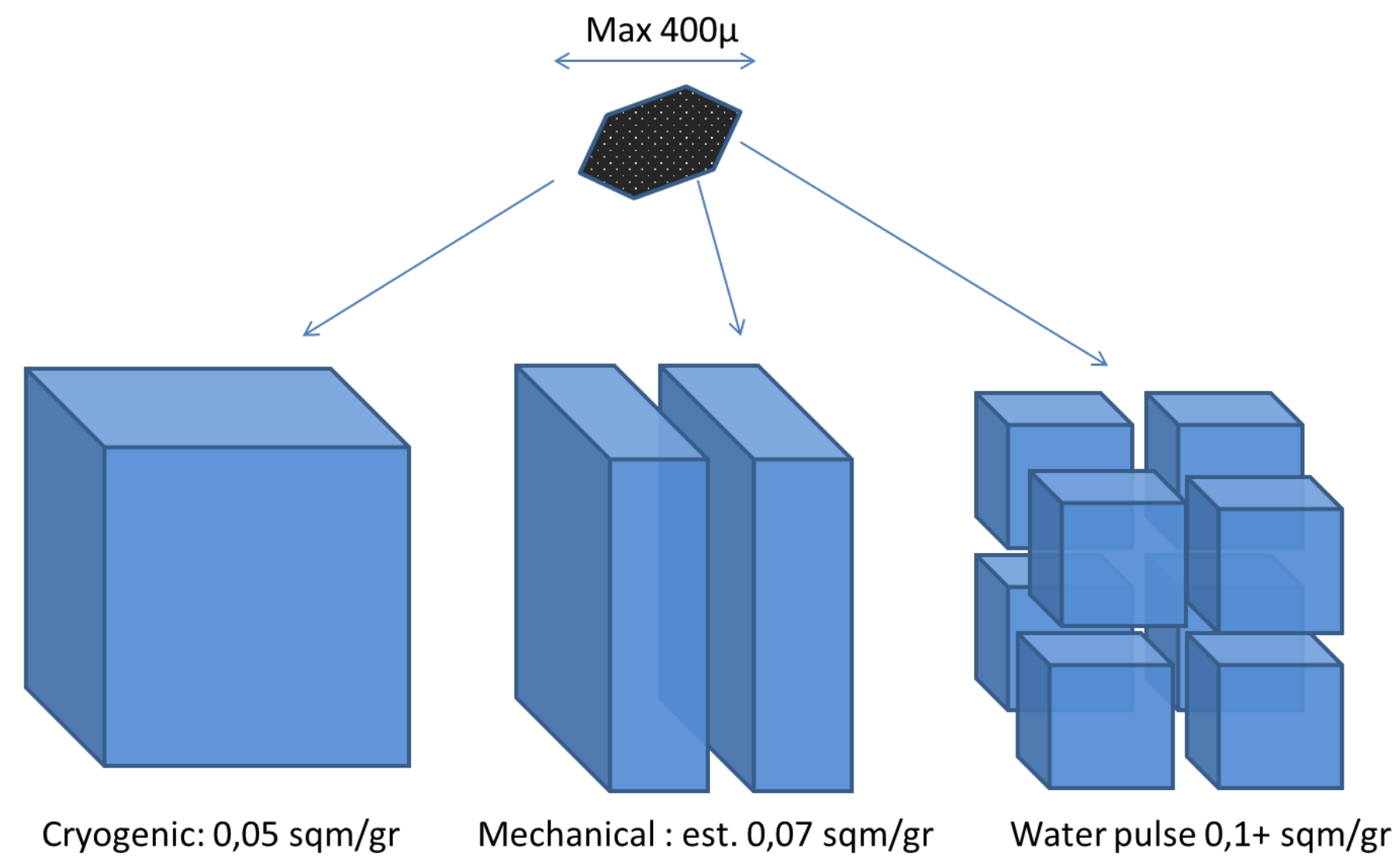


## Waterpulse™

2  $\mu\text{m}$  magnification

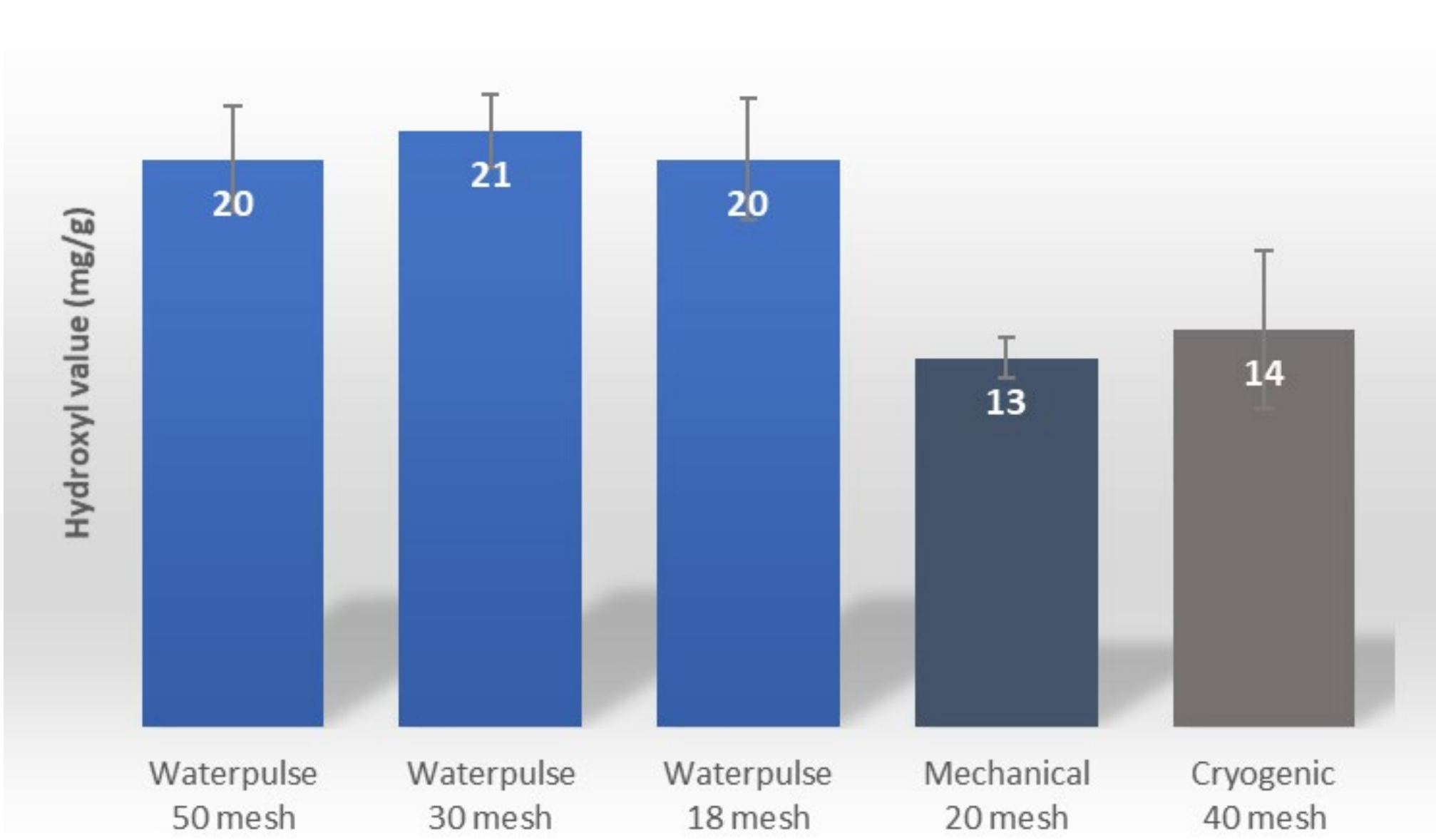
# waterpulse™ - Surface density

Graphic modeling surface density for rubber particles (reference measure 0-400μ size)

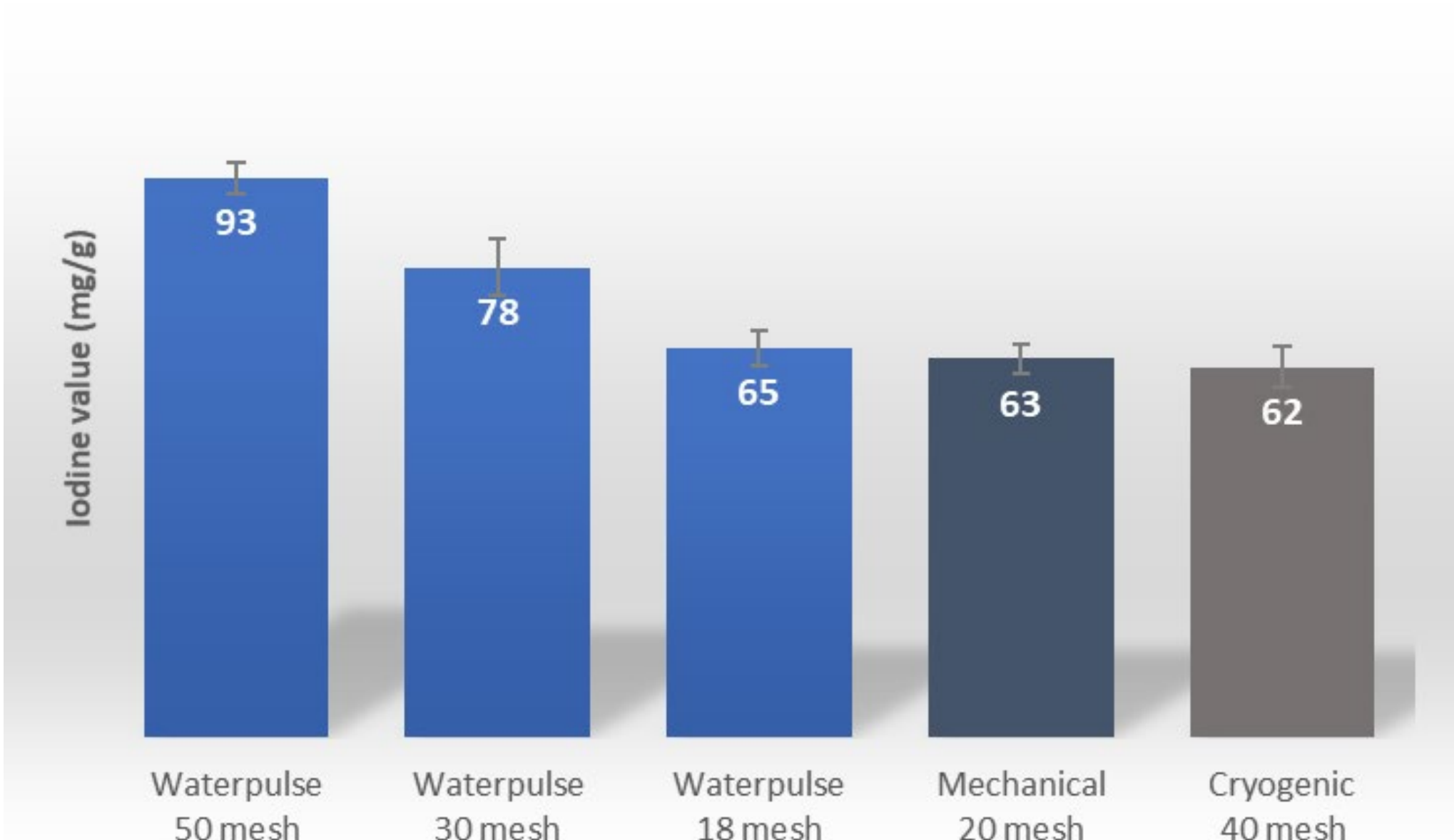


# Rubber powders chemical composition

HYDROXYL VALUES



IODINE VALUES



## APPLICATION SEGMENT

# TIRES / RETREAD

- Many tire manufacturers already add **2-3% of MRP** (cryogenic) or **reclaim**
- **Up to 10% waterpulse™** powder can be added without compromising performance
- This has a **positive impact on cost and sustainability**, while helping to solve the problem of end of life tires



# Tests in agricultural tread tire compound – 7% addition

Non-Optimized Compound				Optimized Compound			
7%7%				7%7%			
Loss vs reference	CWN 0-400	Relative to ref	Ref.	CWN 0-400 +S	Relative to ref.	Ref.	values
Tensile strength [MPa]	14.6	-14%	17	16	-1%	16.1	MPa
Elongation at break %	592	-3%	609	568	0%	569	%
Modulus 300%	5.8	-5%	6.1	6.3	0%	6.3	MPa
Tear resistance (crescent + nick)	66.2	2%	64.9	60.4	6%	57.1	N/mm Shore A
Hardness	57	2%	56	58	2%	57	
Rebound	32	-3%	33	33	0%	33	%
Abrasion (loss is good)	110	-11%	124	115	-11%	129	mm3

# Comparison with reclaim - truck tread compound

waterpulse™ powder performance comparison versus high quality reclaim\*

- Meet tire manufacturer performance requirements at 10 and 20 phr
- Changes to tensile strength and elongation can be minimized by an optimization of the cure package
- Processing aids are often added in order to bring the compound viscosity back down

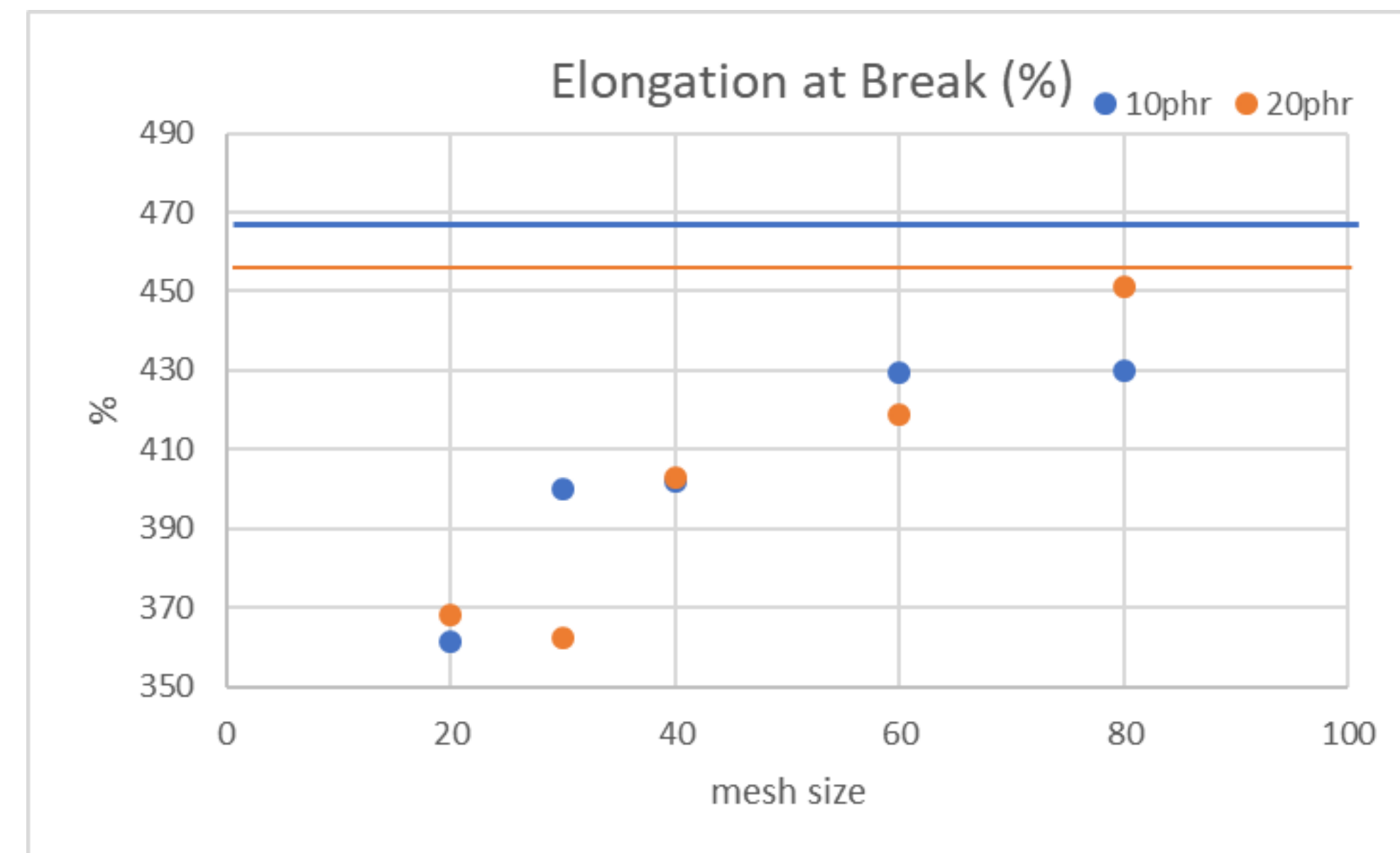
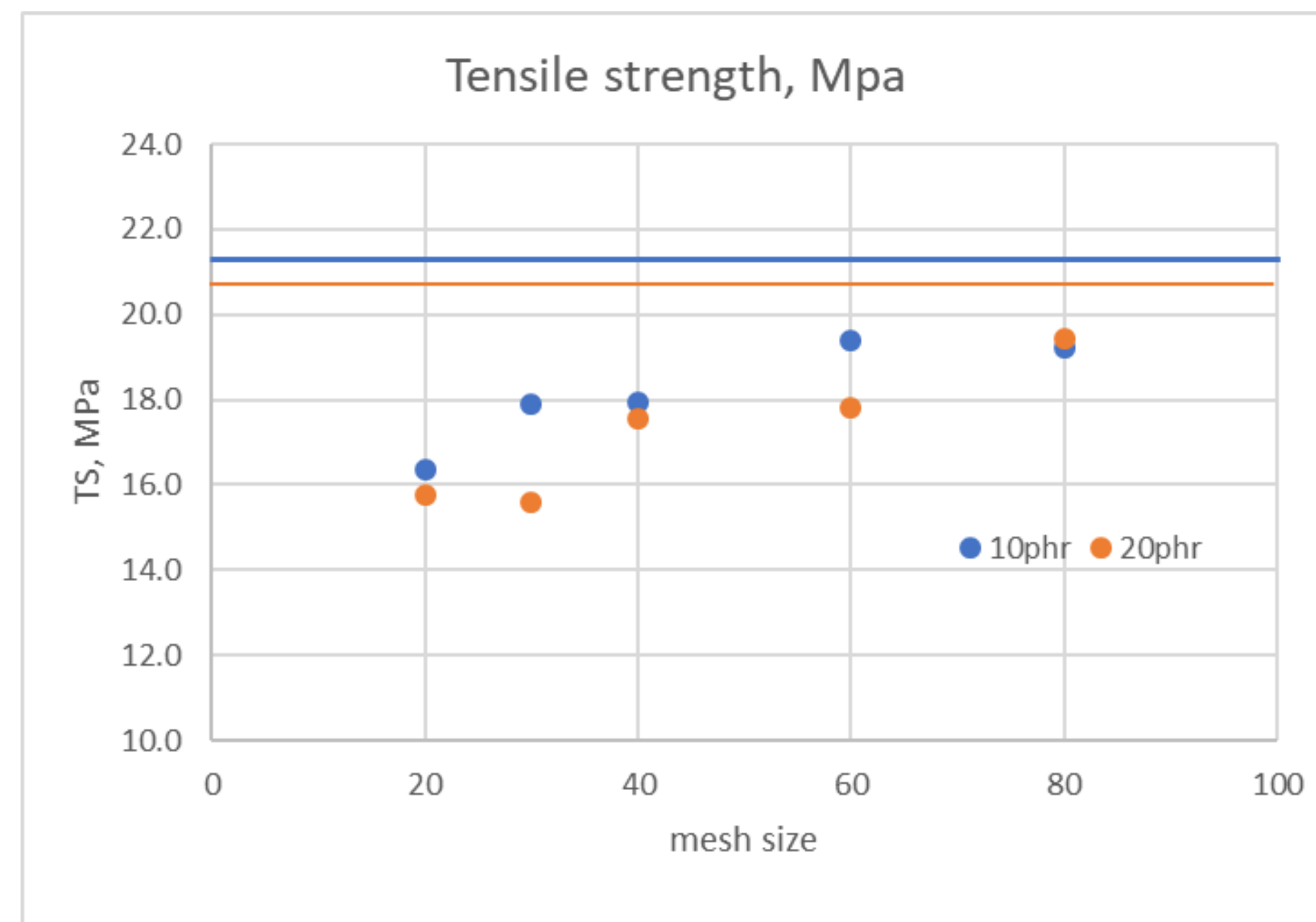
Parameter	Unit	Reference	Reclaim - 10phr	Reclaim - 20phr	waterpulse- 10 phr	waterpulse - 20 phr
Mooney (1+4)100	MU	<b>65.77</b>	0.6%	0.4%	6.9%	12.9%
ts2	mins	2.42	-2.5%	0.8%	-2.9%	-5.8%
t90	mins	6.47	-1.2%	-2.9%	-3.7%	-7.9%
MH	dNm	17.04	-6.6%	-12.1%	-3.0%	-6.4%
Hardness, Shore A	3s	66.51	-1.1%	-3.0%	-0.5%	-1.2%
M300	MPa	12.31	-9.0%	-10.4%	-2.6%	-6.2%
Tensile Strength	MPa	20.90	-13.1%	-17.1%	-5.3%	-10.5%
Elongation	%	462.06	-3.7%	-4.8%	-2.0%	-4.2%
Tear resistance	N/mm	90.36	1.5%	15.5%	-5.6%	5.5%
Abrasion Resistance	mm <sup>3</sup>	111	2.9%	2.8%	0.0%	0.6%

\*The reclaim used as benchmark is from the leading supplier to tire manufacturers in Europe

# Comparison with Chinese ambient grinding powders - truck tread compound

waterpulse™ performance comparison versus various mesh size of ambient grinding powders sourced in China

- Blue dots represent Chinese powders at 10 phr, Orange dots represent Chinese powders at 20 phr
- Blue and Orange line represent 50 mesh waterpulse™ powder performance



# MARKET APPLICATIONS

## DEVELOPING PERFORMING RUBBER MATERIALS

New materials enhanced with **waterpulse™** can be manufactured across a wide range of industries, from building and construction, to automotive and transportation, footwear, 3D printing, and beyond.



## CASE STUDY

# THERMOPLASTIC ELASTOMER

Joint customer project performed to assess processability in the compounding and in injection molding:

- TPO and TPU, 10 – 20 % waterpulse™ powder
- Easy compounding and molding process
- Good mass coloring effect, in all samples
- Low odor in comparison to other rubber recyclates (powder or granulate)



## CASE STUDY

# AUTOMOTIVE RUBBER MOLDED PARTS

- Rubber or PU-Rubber parts, 10 to 25 % addition
- Approved use at 1<sup>st</sup> tier supplier
- Outperformed MRP 80 mesh in benchmarking study

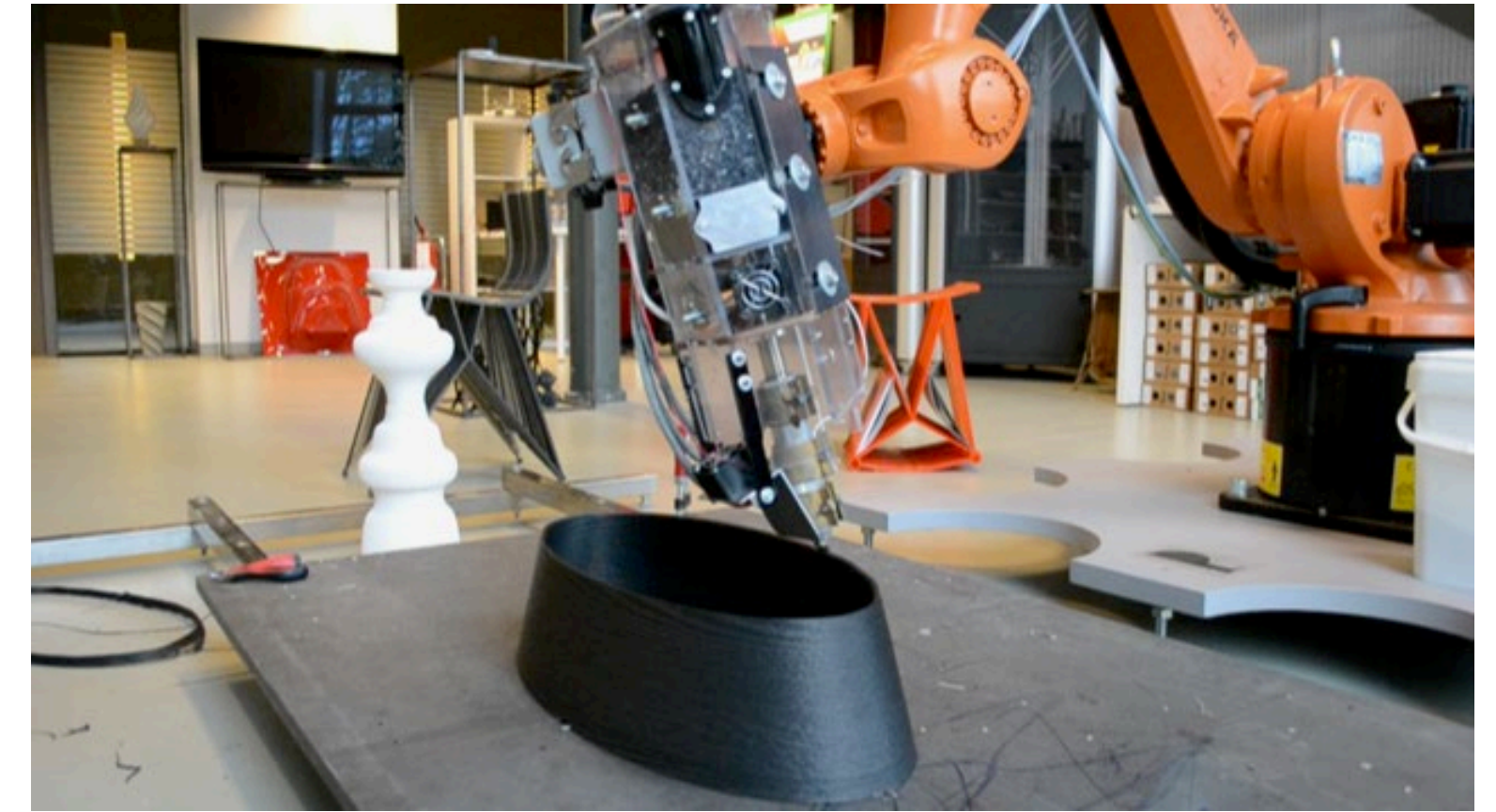


## CASE STUDY

# 3-D Printing

In the form of filament or directly from compound:

- Impart elastomeric properties to relevant articles
- Respond to demand of makers or end-users seeking to introduce green or sustainable solutions in specialized markets
- Supporting the maturation of additive manufacturing from a prototyping technology to an end use part production process



## CASE STUDY

# PARQUET FLOORING ADHESIVE

- Demonstrate capabilities to integrate recycled, post-consumer constituents in polyurethane systems
- Impart sound absorbing properties to parquet flooring
- Architects and builders are looking for new solutions to satisfy public demand for environmentally responsible structures



Adhesive layer

# INCREASING ADOPTION IN TIRES

The following criteria have been identified by tire manufacturers\* as important to increase adoption of recycled materials:

- **Economic advantage**
- **Sustainable business model of suppliers**
- **Positive impact on Life Cycle Analysis**
- Government incentives
- **Sustainable quality and production volumes**



The waterpulse™ technology will be introduced in China in 2020 by our Chinese partner – together we can fulfill all the criteria



\*From panel discussion at Tire Technology, Hannover, 2019

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