Bridgestone and Michelin to present progress from “Call to Action” Efforts

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OBJECTIVE

Share Progress

+ White paper overall context
+ First set of rCB grade and specification
+ Challenges, Regulation, EHS, Waste to Product status, EU REACH
+ Next steps

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Why joint-environmental initiative?

As Industry Leaders, sustainability and circularity is our responsibility

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+ Michelin in Motion “All Sustainable” strategy by 2030 focusing on People, Profit and Planet

+ Ambitions to reach full product circularity: Renewable and recycled material rate of 40% by 2030 and 100% by 2050

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+ Bridgestone has prioritized Ecology and Energy as part of its E8 commitment

+ Ambitions to reach full product circularity: Renewable and recycled material rate of 40% by 2030 and 100% by 2050

Accelerate **IMPACTS**, speed and scale in partnership with industry stakeholders

1.1 CALL TO ACTION JOURNEY

Michelin and Bridgestone delivered a joint presentation in Nov. 2021 at **Smithers rCB conference** in Amsterdam “Call to Action” aiming to:

+ Establish **specifications** for recycled/recovered secondary raw material
+ Coordinate with **regulatory** bodies toward harmonization of standards
+ Help global recycling **ecosystem** understand needs of rubber industry to establish downstream market
+ Assess how **ASTM/ISO** can help normalize framework
+ Partner with key stakeholders on future technologies to better **recycle end-of-life tyres**

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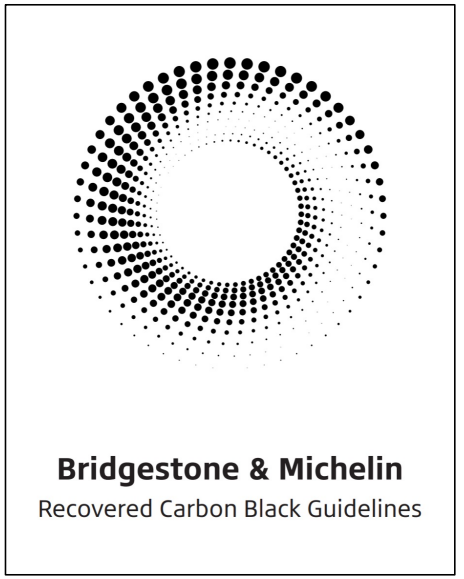
1.2 CALL TO ACTION JOURNEY

+ During the process Michelin and Bridgestone worked in **collaboration** with different stakeholders around the world
+ During the first year we focus our efforts on to establish and proposed a first set of **specifications** for rCB grade
+ Michelin and Bridgestone presented the specification proposal in Nov 2022 at **Smithers rCB** conference in Berlin
+ **White Paper issued Nov 2023**
  (rcbrubber.com)



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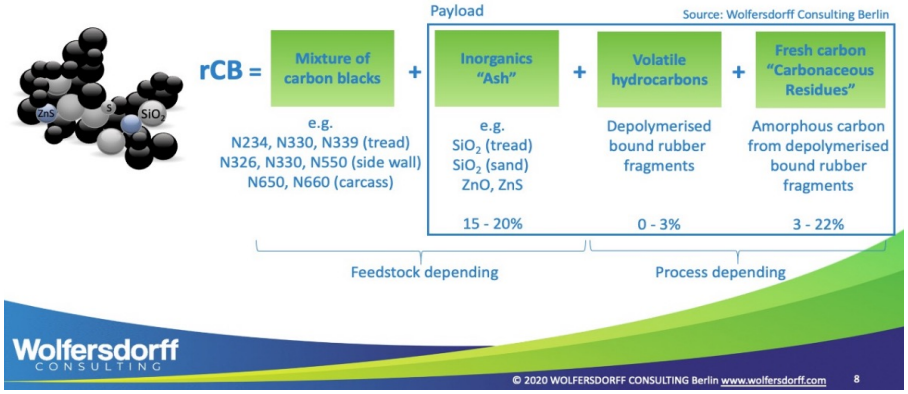
rCB "model" and SD *vs.* HD grades

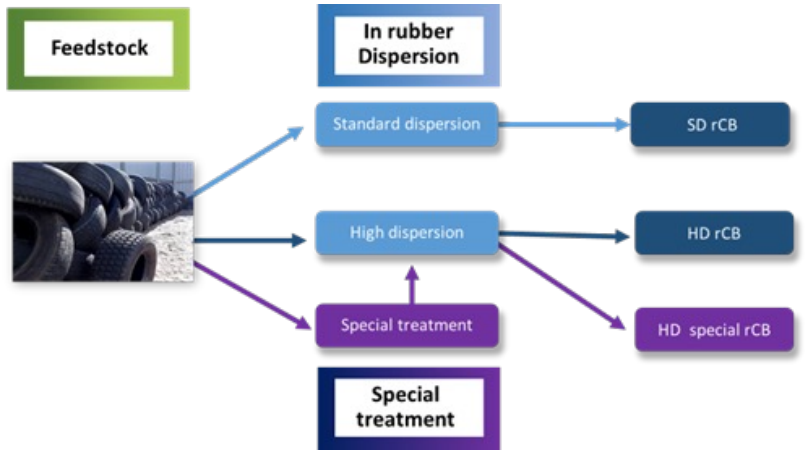
Recovered Carbon Black a new reinforcing filler

+ rCB is a new class of material
+ **Building a model** is necessary to share common understanding and vocabulary
+ Specific characterization methods are not yet fully available

rCB dispersibility - SD *vs.* HD grades

+ Filler dispersion is key for some demanding rubber application
+ Milling proved to be of first importance





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PROPOSAL GRADES DEFINITION : “PRODUCT DEFINITION PART”

Example of multiples grades definitions

rCB grades

+ no single standard today

+ There is room and need of different grades to meet the demand

Definition		Grade A1.1	Grade A1.2	Grade A1.3	Grade B	Grade C	Grade D
Stable ELT feedstock		ELT from PCR, TBR, AG, OTR …			100% TBR	100% OTR	tbd
In rubber rCB dispersion	Laser diffraction (under development by ASTM / WK7 1858).	HD 1.8< D50 < 2.6 µm 7 <D99 < 10 µm	SD 2.5 <D50 <3.5 µm D99 : 20 +/- 2.5 µm	HD 1.8< D50 < 2.6 µm 7 <D99 < 10 µm	HD 1.8< D50 < 2.6 µm 7 <D99 < 10 µm	HD 1.8< D50 < 2.6 µm 7 <D99 < 10 µm	tbd
Post-treatment (e.g. activation, ash leaching …) &/or other special technology		No	No	Yes	No	No	tbd
Ash content	ASTM D1506	>15% / <20% *	>15% / <20% *	<20% **	< 17%	< 17%	tbd

* : Ash content target only if a REACH compliance is achieved through a REACH exemption
** : Ash content target will depend on the post treatment
In addition to dispersibility differentiation, future grade option could include physico-chemical / new “pyrolysis” ELT treatment, leading to rCB with new set of in rubber properties

CERTIFICATE OF ANALYSIS SPECIFICATION PROPOSAL

Examples available in the white paper

+ This is: To ensure product consistency

+ This is **not**: A predictive tool of the in-rubber performances

Definition		Grade A1.1	Grade A1.2	Grade A1.3	Grade B	Grade C	Grade D
ELT		ELT from PCR, TBR, AG, OTR ...			100% TBR	100% OTR	?
SSA by BET (STSA)	ASTM D6556	65 +/- 10	65 +/- 10	to be defined based on the nature and impact of the physicochemical treatment.	tbd	tbd	tbd
Ash content	ASTM D1506	>15% / <20%	>15% / <20%		< 17%	< 17%	tbd
pH	ASTM D1512	6 - 10	6 - 10		6 - 10	6 - 10	tbd
Toluene extract transmission	ASTM D1618	>80%	>80%		>80%	>80%	tbd
Heat loss at 125°C	ASTM D1509	<1.5%	<1.5%		<1.5%	<1.5%	tbd
Total sulphur		< 3.5%	< 3.5%		< 3.5% (tbc)	< 3.5% (tbc)	tbd
Sieve residue (35 mesh)	ASTM D1514	10 ppm	10 ppm	10 ppm	10 ppm	10 ppm	tbd
Sieve residue (325 mesh / 44m)	ASTM D1514	300 ppm	700 ppm	300 ppm	300 ppm	700 ppm	tbd
Pellet hardness	ASTM D5230	< 80cN **	< 80cN **	< 80cN **	< 80cN **	< 80cN **	tbd
Pellet fines content	ASTM D1508	< 5% **	< 5% **	< 5% **	< 5% **	< 5% **	tbd

Today's rCB specifications are mostly based on CB characterization methods with an aim to guarantee product consistency

2023/2024: POTENTIAL

In rubber properties:

+ **Particle size distribution** both before and after pelletization (especially for HD grades): Method under development by ASTM D36 Committee.

+ **Modified OAN**: ASTM confirmation of the interest, definition of specifications

+ **Evaluation of the polymer-filler interactions**: Standard Test Method for Recovered Carbon Black—Rheological Non-Linearity of a Rubber Compound by Fourier Transform Rheology ASTM D8491.

New classification from ASTM:

+ **Under study by WK84831** Recovered Carbon Black needs to be classified in types according to tests methods in order to facilitate specifications between producers and customers. The title and scope are in draft form and are under development within this ASTM D36 Committee.

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REGULATION

It is the rubber industry aim to ensure that rCB comply to all current environmental and human health regulation globally

Specific focus in EU on

+ **EHS** (Environmental, Health and safety) : Manufacturers of rCB should collect analytical data to provide an appropriate Safety Data Sheet
+ **Waste to Product status :** Harmonized End of Waste criteria for end of life tire derived material are the key for market development in Europe
+ **EU REACH** (Registration, Evaluation, Authorization and restriction of usage of chemicals) requirement for all chemical substances

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PERSPECTIVE ON THE FUTURE OF rCB

Perspective:

+ Bridgestone and Michelin expect that conditions will exist for the rCB market to reach up to 1 M tons*

- Current rCB capacity that meets proposed specification is a small percentage compared with the overall carbon black market
- The current rCB spec won't allow for a total substitution of all grades of Virgin CB (vCB)

+ To support this growth, we will need to continue enhancing specifications & methods (ASTM, ISO) :

- Consistency (Ash content, Toluene Discoloration, Organic Volatile Content defined by ASTM D36 committee)
- In-Rubber Properties (Dispersion/Pelletization, Modified OAN) progress on filler-polymer interaction evaluation ASTMD8491
- Environmental Impact (LCA compared to vCB based on clear assumptions)

+ There is a need to continue working to develop new pathways to increase "sustainable CB" use in rubber industry (sCB from TPO or renewable oil, etc.)

- This effort must be enabled by open and traceable sets of independent certifications to guarantee product sustainability

+ It is only the beginning of the journey, Bridgestone and Michelin initiatives will continue under ETRMA Pyrolysis TF team to explore ways to upgrade and expand the proposal to contribute to an increase of usage of sustainable material in tyre application according to tyre industries ambition

*Based on market assumptions and 3rd party expert input

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ACKNOWLEDGEMENT

ANNEXES