



**MICHELIN**

A BETTER WAY FORWARD

NOVEMBER  
19,  
2021

***TIRE AND ROAD  
WEAR PARTICLES***  
*STATE OF KNOWLEDGE*



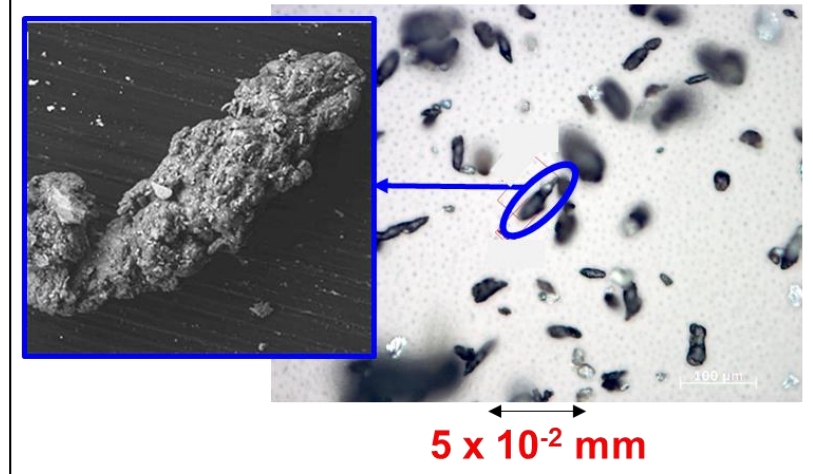


## WHAT ARE TIRE AND ROAD WEAR PARTICLES?

- Tire and road wear particles (TRWP) are generated by friction between the road and the tire during driving. They are a consequence of the grip on the road, essential for safety
- These TRWP have an average density of 1.8, heavier than water, they are a mix of rubber and road debris
- Tire and road wear particles emissions depend on tire design and road surface. The quantity of TRWP emitted vary greatly also with weather, driving style, car specifications and road typology.
- It is estimated that 1 Million tons of TRWP are emitted yearly in Europe due to transport.

### TRWP

- Tire and road wear particles (TRWP) are **tiny debris produced by necessary friction** between tires and road surface
- TRWP is a **mixture** of tire tread and materials from the road surface





## **HOW TO MEASURE THE CONTRIBUTION OF TIRE WEAR IN AIR POLLUTION ?**

- **Direct measurements of PM concentration in the air:** take samples in major cities and analyze the content of the samples to detect origin of the particles. This is the only reliable source of data today.
- **Inventory and projections:** those models need to be calibrated on real life emissions and data. Today, the model used to calculate contribution of tire and road wear particles has never been calibrated on direct measures. Those models are widely used in the literature and for regulatory purposes to estimate the primary PM emissions from tyre wear. This model relies on tire « emission factors » in mg/vehicle/km that have never been directly measured. The tire Industry is proposing a plan to establish those « emission factors » based on direct measurements to calibrate the model and assess its performance and accuracy.
  - Michelin publishes a technical document available on our website to propose a scientific method to measure directly the emission factors of a tire (on [www.michelin.com](http://www.michelin.com))





## **TRWP ARE MINOR CONTRIBUTORS OF AIR POLLUTION**

- Direct measures of air pollution in major cities around the world state that TRWP are minor contributors to air pollution :
  - Less than 1% of PM10 with an average of less than 1  $\mu\text{g}/\text{m}^3$
  - Less than 0,2% of PM2.5 with average of less than 0,1  $\mu\text{g}/\text{m}^3$
  - Limits for health protection is today of 50  $\mu\text{g}/\text{m}^3$  per day during 35 consecutive days for PM10
- These measures were published in :
  - *Tyre wear in particulate matter - No need to panic! Stein, G. & Wünstel, E. & Travnicek-Pagaimo, W. RFP 1/2013, Volume 8; Internatiional conference on rubber and rubber-like material; Kharangpur, India,*
  - *Measurement of airborne concentrations of tire and road wear particles in urban and rural areas of France, Japan, and the United States Panko Et Al 2013*
  - *Evaluation of Tire Wear Contribution to PM2.5 in Urban Environments. Panko et Al 2019*
  - *Ambient air - Determination of the mass concentration of tire and road wear particles (TRWP) - Pyrolysis-GC-MS method ISO 2017*



## **CONTRIBUTION OF TRWP TO WATER POLLUTION**

- This subject has progressed but still present significant challenges
- TRWP are settling very quickly in the sediments and decomposing fast also (half life of 16 months)
  - *Cadle 1980, Deltares 2017, Wagner 2019, Bänsch-Baltruschat 2020, Pr Thompson 2020, rapport DEFRA 2020, Bondeline 2020*
- Roadside water retention and water treatment plants are very efficient to capture the TRWP that may reach them.
  - *Eisentraut 2018, Vogelsang 2018, Klockner 2019*
- Toxicity studies are still very young
  - *Toxicity studies conducted by the TIP by applying known protocols concluded to a very low risk*
  - *Tian (Dec 2020) found a highly toxic substance called 6PPD-Quinone to a very specific kind of salmon (Coho), the 6PPD-Quinone may be a transformation product of the antioxidant from tires. This 6PPD-Quinone was unknown to the scientific community before.*
  - *J. McIntyre (Aug 2021) shows a low toxicity of this 6PPD-Quinone for the common salmon (Chum)*
  - *Hiki et Al, (Environmental Science and Technology letters Aug. 2021) demonstrate the absence of toxicity of 6PPD-Quinone even at very high concentration on 4 fresh water species.*





## **MICHELIN HAS LONG BEEN COMMITTED TO A BETTER USE OF MATERIALS**

- Michelin has been engaged for a long time in leadership for a better use of materials. This means tires that have excellent performances longer and offer more longevity with the same amount of rubber to wear. This design philosophy translated in a progressive reduction of wear particle emissions from our tires. Since 2015, we have reduced by 5% the particle emissions of our MICHELIN Tires
- On the same vehicle in the same usage, the gaps of wear particles emissions from different tires tested by a third party can vary in a ratio from 1 to 6. That is why Michelin favors a regulation that would limit the level of wear particles emissions of all tires worldwide. Michelin contributes with the ETRMA members to the definition of a standardized test method of emission rate of road and wear particles.
- Already recognized for the longevity performances of its tires, Michelin commits to show the way by continuing to reduce the wear particle emissions of its products.



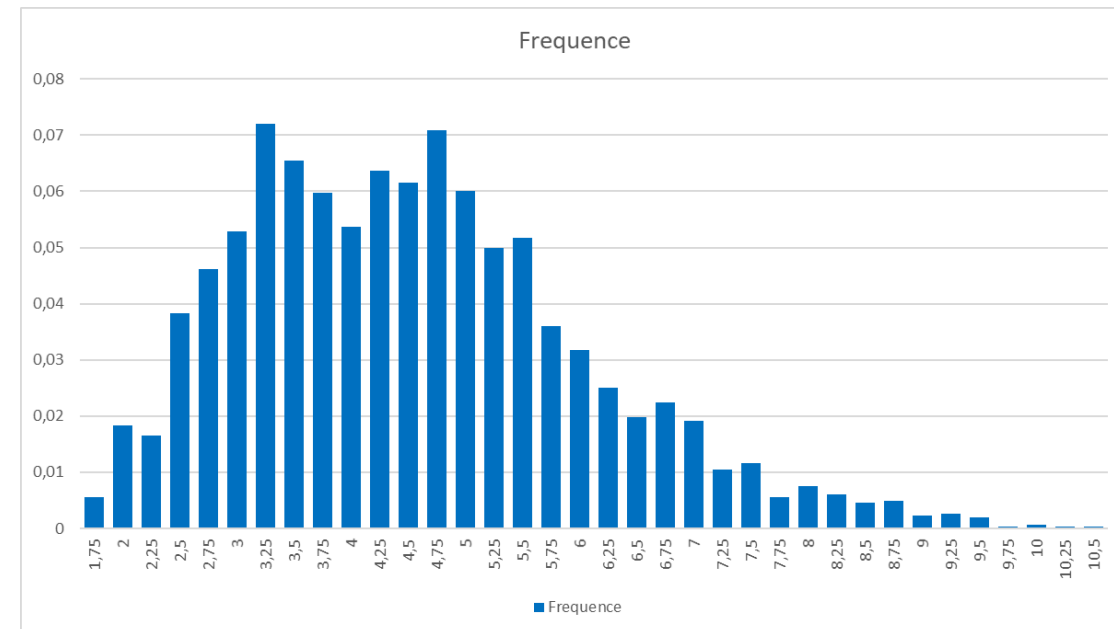


## ***EVEN IF WE ARE ALREADY VERY WELL POSITIONED ON THE MARKET, WE WILL CONTINUE TO PROGRESS***

- Michelin leader in emission rate in 29 tests out of 35 and 2 or 3rd on the remaining 6.\*
- Our new products reduces wear particle emissions :
  - MICHELIN Primacy 4 **16% better** than MICHELIN Primacy 3
  - MICHELIN e.Primacy **20% better\*\*** than MICHELIN Primacy 4
  - MICHELIN CrossClimate 2 **13% better** than MICHELIN CrossClimate+
  - MICHELIN Pilot Sport 4 **8 % better** than MICHELIN Pilot Sport 3

- The overall performance of the market  
(measured) varies from 1,75 to +10 g/100 km

\*external studies carried out by DEKRA between 2013 and 2018 on 2000 tires from the market  
\*\* DEKRA tests for the launch of MICHELIN e.Primacy on 205/55R16 91V and 225/45R17 94W





# FEW EXAMPLES CALCULATED FROM AUTOBILD TEST OCTOBER 2021

- Calculation for 4 tires driven 20,000 kms (particles weight for tires only)

## TEST & TECHNIK

SO VIEL GUMMI VERLIERT EIN REIFEN

**1,7 KG**  
Michelin

Hersteller	Michelin	Sumitomo	Dunlop	Goodyear	Continental	Viking	Nokian	Pirelli
Gewichtsverlust per 1000 km in Gramm pro Reifen	211 Gramm	24,5 Gramm	25,8 Gramm	272 Gramm	28,8 Gramm	29,0 Gramm	29,4 Gramm	31,5 Gramm
Gewichtsverlust Jahresfahrleistung 20.000 km/Fahrzeug	1,69 Kilogramm	19,6 Kilogramm	20,6 Kilogramm	2,18 Kilogramm	2,30 Kilogramm	2,32 Kilogramm	2,36 Kilogramm	2,52 Kilogramm

Multipliziert man die Jahresfahrleistung von vier Reifen, ergibt sich im günstigsten Fall ein anfallender Reifenabrieb von knapp 1,7 Kilogramm. Gummi- und Kunststoffpartikel, die in der Luft

Maxxis	Falken	Hera	Dzooek	Vredestein	Greene	Bridgestone	Giti
32,3 Gramm	32,5 Gramm	33,6 Gramm	34,7 Gramm	35,8 Gramm	38,8 Gramm	39,2 Gramm	44,6 Gramm
2,58 Kilogramm	2,60 Kilogramm	2,69 Kilogramm	2,78 Kilogramm	2,86 Kilogramm	3,10 Kilogramm	3,14 Kilogramm	3,57 Kilogramm



schweben oder im Straßengraben landen. Die Unterschiede zwischen den Kandidaten sind überraschend groß: der Giti erzeugt auf gleicher Strecke die doppelte Abriebmenge.

Michelin  
CrossClimate2



Market Median\*\*



Less performing tested\*\*



- Results Autobild from October 2021 on 17 tires All Seasons and Michelin studies out of 282 tests
- \*\*results extrapolated from Autobild tests and all 35 Dekra external tests performed between 2013 and 2018







## **MICHELIN MOBILIZED TO ELIMINATE THE LESS PERFORMING TIRES FROM THE MARKET**

- The scientific studies needed to close the gaps on fate and toxicity will take time
- But it is possible to start acting right now both individually as collectively
  - *Collectively by defining a standard test and using this test to eliminate the least performing tires from the market with a threshold regulation.*
  - *Individually, with innovation efforts leading to design tires contributing even more to the reduction of tire wear particle emissions. The Michelin Group already recognized for the performances of its products, commits to show the way by reducing the wear particle emissions of its product beyond the 5% reduction already gained since 2015.*





## ***ELECTRICAL VEHICLES IMPACT***

- We will see an acceleration of the transition from ICE to electrical vehicles
- An electrical vehicle could generate 10 to 20% more tire and road wear particles due to its weight
- Michelin, with the excellence of its history in improving tire longevity is well placed to help to compensate part of the additional emissions, while maintaining the performances expected by regulators or consumers (noise, comfort, traction, rolling resistance, handling, load carrying capacity...)



## **DISCLAIMER**

"This presentation is not an offer to purchase or a solicitation to recommend the purchase of Michelin shares. To obtain more detailed information on Michelin, please consult the documents filed in France with Autorité des marchés financiers, which are also available from the <http://www.michelin.com/eng/> website.

This presentation may contain a number of forward-looking statements. Although the Company believes that these statements are based on reasonable assumptions as at the time of publishing this document, they are by nature subject to risks and contingencies liable to translate into a difference between actual data and the forecasts made or inferred by these statements."



**CONTACTS**

**Edouard de PEUFEILHOUX**  
**Pierre HASSAÏRI**  
**Flavien HUET**

27, cours de l'île Seguin  
92100 Boulogne-Billancourt – France

23, place des Carmes Dechaux  
63040 Clermont-Ferrand Cedex 9

*investor-relations@michelin.com*