U.S. TIRE MANUFACTURERS ASSOCIATION

Tire and Road Wear Particles – generation and mitigation factors

November 12, 2020

Health Effects Institute

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A BETTER WAY FORWARD

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RUBBER INDUSTRIES

TOYO TIRES
driven to perform

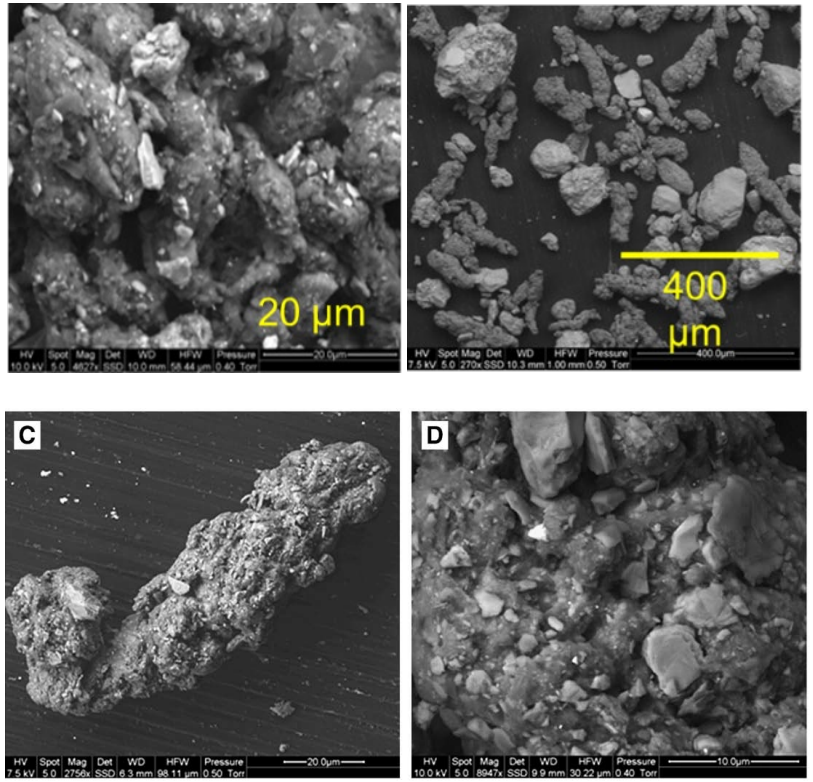
YOKOHAMA

The functions of the tire

- Support weight of the vehicle
- Provide precise/effortless everyday steering
- Provide stable & effective emergency steering
- Grip to accelerate
- Grip to brake
- Perform in wet conditions
- Perform in winter conditions
- Provide a quiet ride
- Absorb vibrations and impacts
- Provide long wear life
- Resist heat, overload, speed, low inflation
- Comply with Federal Motor Vehicle Safety Standards

Why do tires produce particles?

- Tires are a vehicle's only connection to the road.
- The grip between a tire and the road surface is essential to tire safety and performance.
- The tires critical grip on the road, creates tire and road wear particles (TRWP) due to abrasion that occurs during accelerating, braking and cornering.
- TRWP are a mixture of tire tread and road surface.



Kreider, M.L., J.M. Panko, B.L. McAtee, L.I. Sweet and B.L. Finley. (2010) *Physical and Chemical Characterization of Tire-Related Particles: Comparison of Particles Generated Using Different Methodologies*. Sci Total Environ. 2010 Jan 1;408(3):652-9

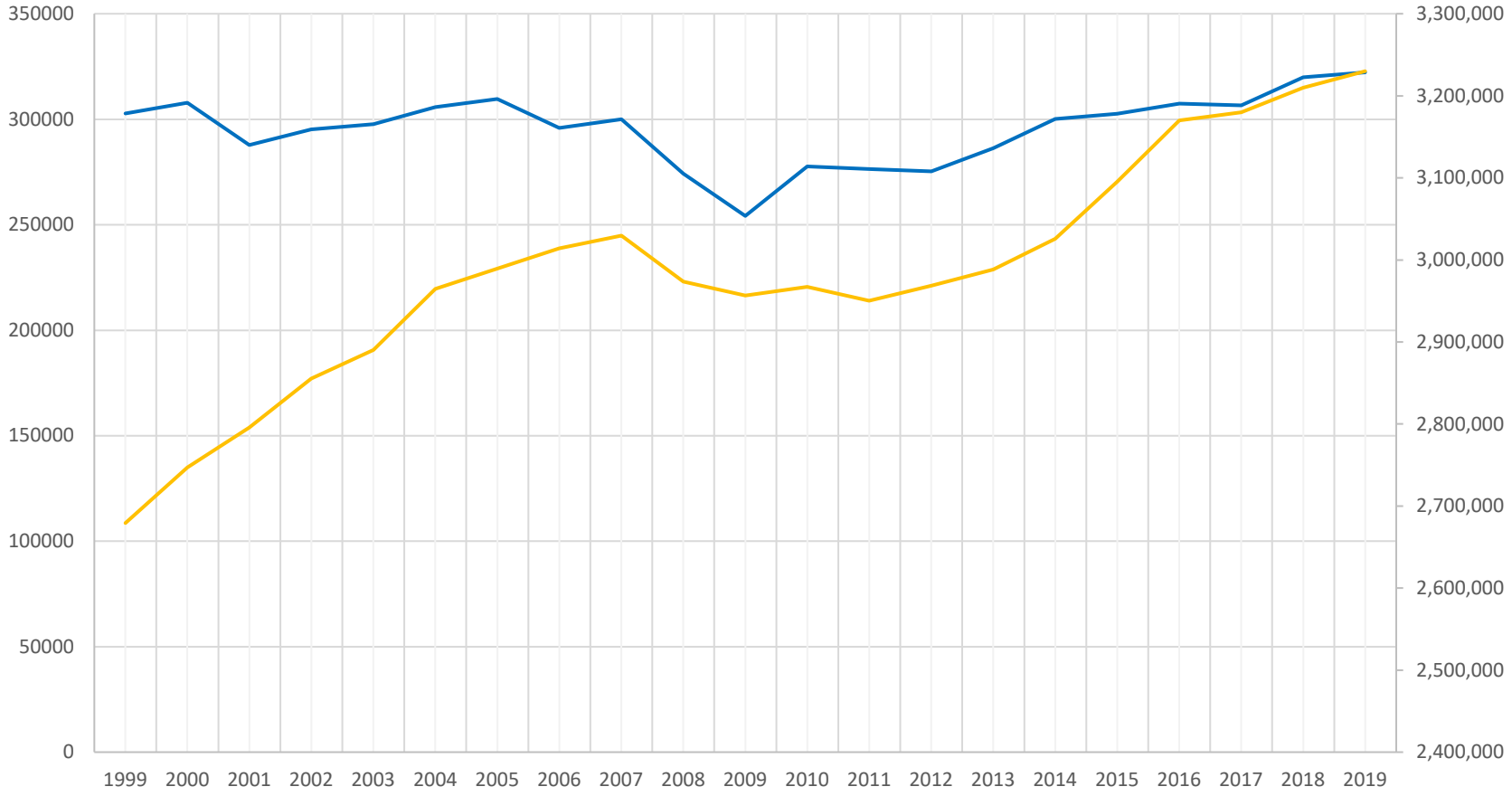
Many factors impact the generation of particles from tires

- Road surface
- Vehicle characteristics
- Driving behavior and tire maintenance
- Tire design
- Weather
- Road topography

Tires today are lasting longer than ever before

Tire Shipments in the U.S.
in thousands
(blue)

USTMA estimate of total number of PLT and TB tires shipped from the manufacturer or importer to the customer in the U.S. market.



Vehicle Miles Traveled (yellow)

Dept. of Energy estimate reflecting light-, medium-, and heavy-duty vehicles.

https://www.afdc.energy.gov/data/10315

Data gaps

- **Road pavement surface impact** (roughness and frictional characteristics)
  - Use of rubber modified asphalt mitigates the generation of TRWPs compared with concrete roads (Arizona Department of Transportation 2006. Tire Wear Emissions for Asphalt Rubber and Portland Cement Concrete Pavement Surfaces. Contract Number KR-04-0720-TRN.)

- **Contribution of EV's to increased TRWP generation**
  - Increased vehicle weight, torque
  - Trade-offs between exhaust and non-exhaust emissions

- **Airborne modeling improvements**
  - Improved input to EPA MOVES model

THANK YOU

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U.S. TIRE MANUFACTURERS ASSOCIATION

APPENDIX 1 – TIRE WEAR CALCULATION AND DATA INPUTS

U.S. TIRE MANUFACTURERS ASSOCIATION

USTMA Tire Wear Rate Calculation – United States

Wear Rate Calculation - U.S. Total

Factor	Tire Type			Notes
	Passenger Car	Light Truck	Truck/Bus	
Average Weight of Tire (lbs)	26.00	50.60	117.19	Average of actual data from multiple USTMA companies
Tread Weight (lbs)	8.35	16.70	29.64	Average of actual data from multiple USTMA companies
Tread Depth (in)	0.31	0.47	0.56	Average of actual data from multiple USTMA companies
Under Tread (in)	0.08	0.12	0.09	Average of actual data from multiple USTMA companies
Total tread (in)	0.39	0.59	0.66	Average of actual data from multiple USTMA companies
Wear to Depth (4/32 for passenger cars and light trucks; 6/32 for truck-bus) (in)	0.18	0.35	0.38	USTMA member recommendation
Percent tread worn (%)	0.46	0.59	0.57	Percent worn = Wear to Depth / Total Depth
Potential Worn tread weight (lbs)	3.87	9.78	16.94	Worn tread = % tread worn * tread weight
Tread groove void factor (%)	0.30	0.34	0.15	Average of actual data from multiple USTMA companies
Total Worn Tread weight per tire (lbs)	2.72	6.45	14.40	Total Tread Worn = (1-Groove factor void)*Potential Worn Tread Weight
Tires shipped (millions)	256.41	36.93	51.32	Average 2016-2018 USTMA Shipment Data
Distance traveled (millions of vehicle miles)	2,478,921	395,805	314,077	Average 2016, 2017, 2018 Federal Highway Data
Wear Rate (lb/100 vehicle miles)	0.028	0.06	0.235	Wear Rate = Total Tread Worn * Number of tires shipped / Distance traveled
Yearly Worn Tread Weight (tons)	348,588	119,136	369,394	Yearly Worn Tread Weight = Total Worn Tread Weight * Number of Tires Shipped
Registered Vehicles (millions)	215.72	33.92	13.30	Average 2016, 2017, 2018 Federal Highway Data
Yearly Miles per Vehicle	11,492	11,668	23,607	Miles/Vehicle = Distance Traveled/Number of Registered Vehicles
Total Vehicle Miles per Tire	9,668	10,719	6,120	Miles/Tire = Distance Traveled/Number of Tires Shipped

** Numbers may not add due to rounding*

Data inputs – USTMA Shipment data

Passenger Car

Shipment data included “Radial Industry OE” + “Total Industry Replacement” for 2016, 2017, and 2018. The average for the three years was used in the calculations.

Light Truck

Shipment data included “Radial Industry OE” + “Total Industry Replacement” for 2016, 2017, and 2018. The average for the three years was used in the calculations.

Truck-Bus

Shipment data included “Radial Industry OE” + “Total Industry Replacement” for 2016, 2017, and 2018. The average for the three years was used in the calculations.

Data inputs: Vehicle Miles – United States

- Data sources:
  - The data for the number of registered vehicles was found at: https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances.
  - The data for the number of vehicle miles driven was found at: https://www.bts.gov/content/us-vehicle-miles.
- Data years:
  - Data was obtained for 2016, 2017, and 2018.
  - The average for the three years was used in the calculations.

- Annual "vehicle miles driven" data:
  - Source: U.S. Department of Transportation
  - The following categories under "Highway, Total" were used in the tire wear rate calculations:
    - Light Duty Vehicle, Short Wheel Base (all attributed to passenger car tires)
    - Light Duty Vehicle, Long Wheel Base (40% attributed to passenger car tires and 60% to LT tires)
    - Truck, Single Unit 2-axle 6 tires or more (all attributed to truck-bus tires)
    - Truck, Combination (all attributed to truck-bus tires)
    - Bus (all attributed to truck-bus tires)
  - The breakdown of the US miles driven was:
    - 77% passenger car, 12% light truck, 10% truck-bus

Data inputs: Vehicle (tire) segmentation

- Vehicle (tire) segmentation – passenger car, light truck, truck/bus
- Based USTMA shipment data, as found in the USTMA FACTBOOK, for 2016, 2017, and 2018.
- The average for the three years was used in the calculations.

Data inputs: Data collected from USTMA members

1. Average Total Tire Weight and Standard Deviation
2. Average Total Tread Weight and Standard Deviation
3. Average Tread Depth and Standard Deviation
4. Average Undertread Thickness and Standard Deviation
5. Average Tread Void Factor % and Standard Deviation

Data inputs: Tire wear out values

- Most tires are not completely worn down to 2/32” around the entire tire before they are removed from service.
  - USTMA and tire retailers recommend replacement when a tire reaches 2/32” in the fastest wearing groove
  - Tires are typically replaced before this point due to road hazard damage, uneven treadwear and customer needs for tire performance due vehicle type, driving needs, weather conditions, etc.
- USTMA member company engineers recommended using tread depth of 4/32” for passenger and LT tires and 6/32” for truck/bus tires as the average tread depth at removal due to the various factors affecting tire replacement