Cryo-Milled Tire Tread (CMTT)

Overview of Production, Characterization and Composition

Cyro-milled tire tread (CMTT) has been used in various research programs as a surrogate for tire and road wear particles (TRWP) because generating TRWP in a laboratory or in the natural environment is time intensive and logistically difficult to collect. However, CMTT used in research has often not been representative of tire tread on the road because it may be produced from a very limited number of tires or may include other non-tread rubber compounds from a tire. As such, the U.S. Tire Manufacturers Association has produced CMTT to provide researchers with a readily available, cost-conscious material for conducting lab experiments related to tire wear.

OVERVIEW OF CMTT PRODUCTION

The CMTT methodology was created by the World Business Council for Sustainable Development's Tire Industry Project (TIP) for producing consistent CMTT particles from study-to-study when conducting TRWP research.

The CMTT procedure consists of: 1) tire selection, 2) removing strips of tread compound from new tires that have not been mounted on vehicles, being mindful not to contaminate with surrounding compound components; 3) cutting the strips of tread into 1 cm3 pieces using a stainless steel cutting die; and 4) cyro-milling the cut tread materials into particles based on defined hammer mill machine set-up specifications. A sample of the generated CMTT is then sieved for size / mass distribution.

TIRE SELECTION PRINCIPLES

CMTT that is representative of the U.S market was produced from tires according to the selection principles outlined below.

Tire Selection Principles and Rationale

Principle	Rationale
1. On-road vehicle tires for passenger car, light truck and truck/bus	Tire types represent the majority of on road vehicle categories. Passenger (79.5%), light truck (11.5%), truck/bus (9.0%) (USTMA Factbook 2019).
2. Replacement tires available for purchase	The volume of replacement tires sold is greater than original equipment (OE) tires manufactured for new vehicles, and there is no significant difference in composition for a given tire type/size/brand between OE and replacement. Truck/bus tires are not sold directly to consumers as such member companies shipped them directly to the lab for tread removal.
3. Tires from each on-road category based on most popular size	Based on tire type and most popular size within each category. Tire were selected from the top five most popular in the passenger car and light truck categories and from the top two most popular sizes in the truck/bus category (USTMA Factbook 2019).
4. Tires that have carbon black or silica as primary filler in tread compound	Tires may have tread where either carbon black or silica-based is the primary filler in the rubber compound. USTMA members selected 1 tire where the majority of the filler is silica-based, and 2 tires where the majority of the filler is carbon black-based, except for members that do not manufacture truck tires, in which case 1 silica-based and 1 carbon black-based tire was provided.
5. Recently manufactured tires	For consistency, USTMA member tires selected for CMTT were manufactured between May 2020 and April 2021.

Tire Type and Percent of the market (USTMA Factbook 2019)

Passenger tires Size (percent of passenger tire shipments)	Light Truck Tires Size (percent of light truck tire shipments)	Truck & Bus Tires Size (percent of truck & Bus tire shipments)
225/65R17 (5.1%)	LT265/70R17 (9.9%)	295/75R22.5 (23.3%)
205/55R16 (4.5%)	LT245/75R16 (9.6%)	11R22.5 (22.1%)
215/55R17 (3.8%)	LT225/75R16 (7.0%)	
215/60R16 (3.3%)	LT275/70R18 (6.4 %)	
195/65R15 (3.0%)	LT265/75R16 (5.9%)	
Total of top 5 = 19.8%	Total of top 5 = 38.8%	Total of top 2 = 45.4%

FOR ADDITIONAL INFORMATION: **U.S. Tire Manufacturers Association** 202-682.4800 | 1400 K Street, NW #900 • Washington, DC 20005 | info@ustires.org

Preparation of CMTT Composite

The CMTT sample is a composite of the three tire types where the amount of each tire type in the sample is proportional to the wear rate data for passenger, light truck and truck/bus tires. USTMA created an estimate for tire wear in the U.S. for these tire types based on tire shipment data provided in the USTMA FACTBOOK for 2016, 2017, and 2018.* The average shipment data for the three years was used in the calculation. The CMTT composite contains:

- 41% Passenger Car Tire
- 14% Light Truck Tire
- 45% Truck/Bus Tire

Proportioning the CMTT based on the USTMA wear rate data provides the most representative mixture of what may be in an environmental system.

Use of CMTT in Environmental Health Research

TRWP are a mix of tire tread and road pavement material. TRWP may also become encrusted with additional matter picked-up from the road surface, including for example, fuel, brakes, sand, and other things resulting from atmospheric deposition. CMTT is comprised of the vulcanized tread rubber compound only and does not contain chemicals or elements arising from pavement or any interactions with pavement. CMTT eliminates non-tire related chemicals and allows the researcher to study only the tread component contribution when trying to understand potential human health and environmental impacts associated with tire wear particles. The CMTT particles approximate TRWP in size range as closely as possible within the limitations of the cryo-milling technology, however, the size distribution percentages can differ somewhat when compared to TRWP.

COMPARISON OF CMTT AND TRWP

Researchers should acknowledge that CMTT particles have limitations and are not a direct replacement for the study of TRWP due to the lack of the road component particles. These differences should be assessed and understood for its impact on the results and conclusions of a study where CMTT has been used.

Consideration	TRWP from road simulator	CMTT
Representativeness	Most representative of tire and road wear particles generated during driving.	Representative of the composition of the tread portion of TRWP. Not representative of TRWP full size distribution or morphology; may not account for thermal degradation or oxidation of tire chemistries occurring during wear. Does not include road particles or other road debris/dust.
Size Distribution	By Volume: 44.7 um (mean)	By Volume: 228 um (mean)
Basic Composition	Thermogravimetric Analysis: Organics: 12% Carbon black: 2.9% Ash: 84.5 %	Thermogravimetric Analysis: Organics: 64.3% Carbon black: 21.8% Ash: 13.2%
Applications	Appropriate for most scientific study pertaining to tire-use conditions.	Most applicable for studies where size distribution and morphology is unlikely to impact interpretation; if used in other applications, limitations/uncertainties regarding size should be discussed/acknowledged.
Tire Selection	Passenger car and light truck tires can be used in the road simulator; cannot currently accommodate truck or bus tires. May need to supply rims on which to mount the tires.	Passenger car, light truck and truck/bus tires can be selected.
Feasibility	Few laboratories can generate; collection efficiency is low, therefore long collection times necessary; likely to be infeasible when large amounts of particles are needed.	Time consuming to remove only tread compound but can generate large quantities of tread particles. To avoid water jet for cutting, need to use industrial sheers or a custom die to use in stamping machine. It is relatively easy to produce large numbers of particles using commercial mills.

* The USTMA Annual Fact Book, U.S. Shipment Activity Report for the Statistic Year, provides information on passenger, light truck, and truck/ bus tires by size from USTMA members for tire shipments in the U.S. It is prepared by the USTMA Market Information Services department, using actual and estimated tire shipments from the prior year supplied by the USTMA member manufacturers.