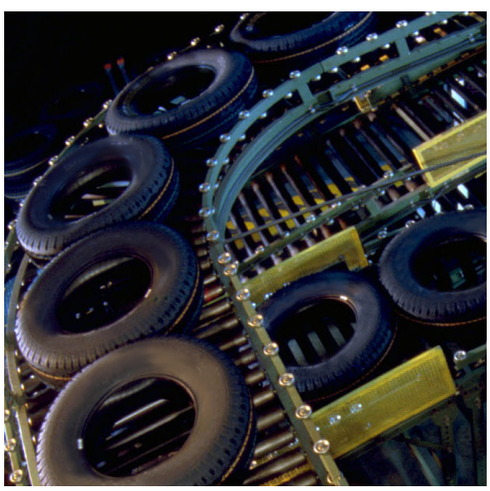
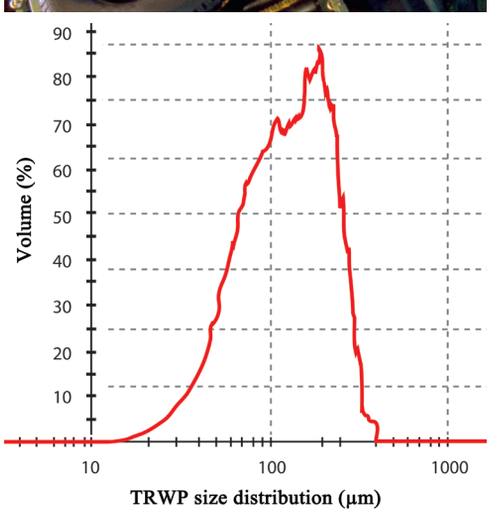
TIP

TIRE INDUSTRY PROJECT

10-YEAR PROGRESS REPORT

(2005-2015)





wbcsd tires

WBCSD is proud to host the Tire Industry Project (TIP) as one of our very successful industry sector initiatives. These programs bring leading companies from within a sector together to take action on sustainability challenges unique to their industry. The combined strength of the participants allows them to scale up the impact of their joint solutions, where a one-company approach would not scale fast enough.

The TIP has made great progress in their 10 years working together; evaluating the chemicals used in their products, the impacts tires have during their lifetime and their ultimate recovery, recycling and disposal. Their most recent work looks to the future and how they can use new nanomaterials to improve their products and reduce their impacts while protecting human health and the environment.

I'm sure that TIP over the next ten years will continue to drive an ambitious agenda. The demand for the product will continue to grow, and sustainability practices must therefore become the norm the industry strives for.

PETER BAKKER
President & CEO, WBCSD
Geneva, Switzerland

*TIP member companies 2005-2015, in alphabetical order

Summary

The Tire Industry Project (TIP) has been operating successfully for ten years, addressing a series of sustainability challenges for the industry. Work has progressed in collaboration with several world-class consultants, an advisory panel of world-leading experts, and a number of key industry stakeholders. Original scientific research, newly invented measuring equipment and techniques, field-testing, new environmental sampling, toxicology studies, and other efforts have helped us make steady progress understanding the challenges we face and improving the sustainability of our companies and the industry. This report summarizes our work.

Introduction

The tire industry is global in scope, producing products in nearly all countries for widespread use on vehicles ranging from bicycles to huge earthmoving equipment. The sustainability of the industry depends not only on solid business and economic practices, but equally on effective management of the impacts these products have on the communities, societies and environments in which they are made, used and managed at the end of their life.

The TIP is a voluntary initiative begun in 2005, currently bringing together eleven leading tire companies (see inside front cover) responsible for 65% of the world's tire production. The Project's purpose is to:

1. **Identify and collaborate on sustainability challenges facing the industry;**
2. **Improve companies' understanding of these challenges; and**
3. **Develop potential solutions to address them.**

The Project operates under the umbrella of the World Business Council for Sustainable Development (WBCSD), a Swiss-based non-governmental organization focused on identifying and scaling up business solutions to build a more sustainable world. The three largest tire companies—Bridgestone (Japan), Goodyear (USA) and Michelin (France)—serve as co-chairs for the project and manage the work program on behalf of all eleven members.

Company membership, work program, team members and funding

Company members of the program ensure broad geographic diversity while covering a majority of the sector's manufacturing capacity.

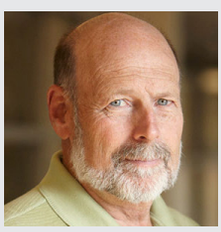
The companies' chief executive officers (CEOs) select the work topics during their regularly scheduled meetings to review results and plan future activities. In general, work topics are chosen based on three factors: (1) the potential impact of the topic on human and environmental conditions; (2) the current level of understanding of the topic; and (3) respect for current competition and anti-trust issues of the participants.

The TIP's work program has investigated a number of major global issues affecting the tire industry, as summarized in this brochure. In several cases, the work has broken new ground in terms of developing new sample collection methods and new analytical techniques. To ensure widespread use of the work, results have been shared with government officials and major trade associations. Results are made available to the public via the WBCSD's website and published in a number of scientific journals.

The Project work has been conducted by a select set of independent consulting organizations that bring leading technical skills to the topics of interest to the TIP. In addition, a globally diverse,

independent Assurance Group (Figure 1) monitors progress, offers input on all work projects, and suggests additional items to be included in the work. WBCSD acts as the overall organizer and moderator of these activities, applying the organization's experience managing various industry sector sustainability programs over the past 20 years. Finally, legal counsel is used to ensure compliance with anti-trust regulations. The program is funded entirely by the company members and led by their CEOs.

Figure 1. Current TIP Assurance Group



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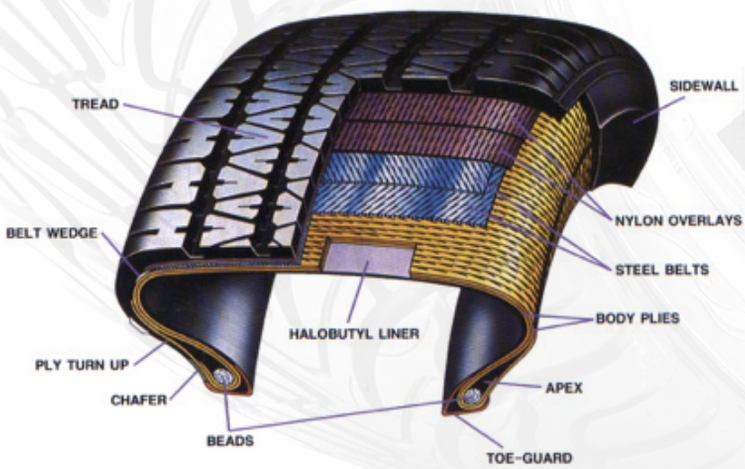
Tires and their impacts

A tire looks like a simple product, but it is not. A typical tire involves dozens of different components made from more than 100 primary raw materials that must be precisely processed and assembled to achieve the right balance between many competing factors including safety, environmental impact, driving pleasure and durability (Figure 2).

Figure 2. Tire Construction



During the life cycle of a tire (Figure 3), there are three major areas where they might impact the environment.

1. Energy and raw materials sourcing and use during manufacture;

2. During use;

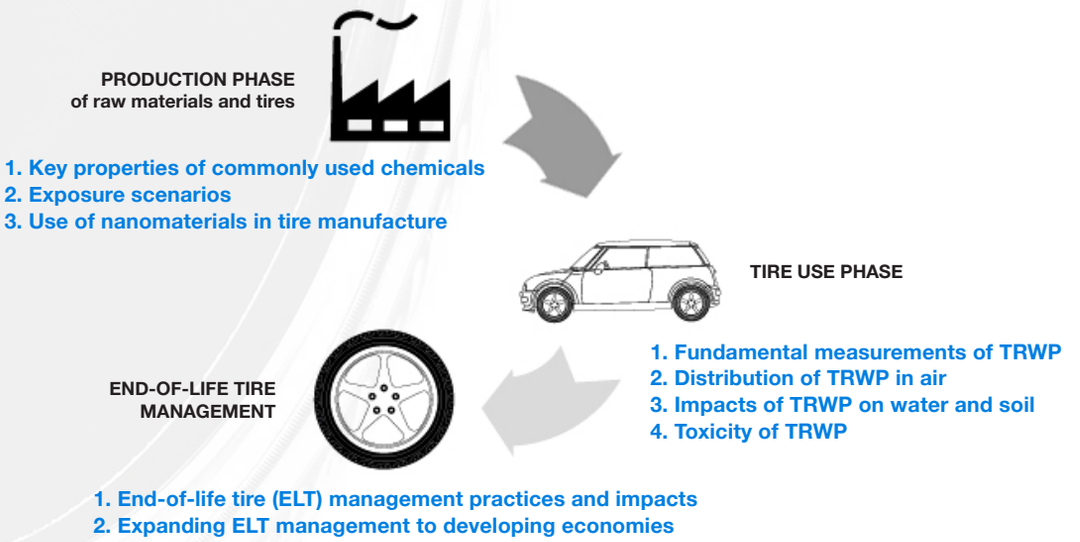
   - Tire wear as vehicles move, which generates and disperses tire and road wear particles (TRWP),

   - Tire rolling resistance, which directly affects vehicle energy use and the resulting greenhouse gas emissions,[1] and

3. End-of-life tire management.

[1] Fuel economy and vehicle greenhouse gas emissions are critical aspects of tire use. They are also highly competitive issues between individual TIP companies. The companies separately conduct their own research and development on these topics and rightfully do not wish to discuss their own innovations with their competitors. The TIP maintains strong compliance standards with competition law. For competitive and legal reasons the companies are not able to collaborate on these issues at this time.

Figure 3. Life Cycle of a Tire



Results to date

1. Evaluation of tire materials for potential health impacts

The Project's initial scoping work examined the availability and quality of existing data for chemical components commonly used in tire manufacturing. A list of more than 50 chemicals was identified. The TIP reviewed available data on chemical, physical and biological properties of these chemicals. This work covered more than 3,000 sources from the scientific literature, including material in English, German, Italian, Spanish, Japanese and Korean from as early as 1895 through the present. This scoping work also identified knowledge gap, and developed a comprehensive plan to fill those gaps in successive years.

The TIP found that many (but not all) of the 50 chemicals had already been characterized by their manufacturers, or will be characterized under a variety of regulatory programs in Europe (REACH), the United States (EPA – TSCA) and Japan (CSCL).[2] Independent exposure assessments for those chemicals studied showed a sufficient margin of safety for human health and the environment based on a variety of literature data and screening models.

The TIP identified a very small number of chemicals as potential candidates for future replacement by safer materials. In addition, the chemical and/or biological properties of some chemicals have not yet been fully determined. In these cases, additional work is needed to fill data gaps and identify possible exposure scenarios. That work will be carried out individually by tire companies and their suppliers under a variety of programs, including those noted above.

2. Environmental fate and transport of tire and road wear particles

People have always known that tires gradually wear down. For some time researchers have asked "what happens to the tire particles that are

[2] REACH is the European program for Registration, Evaluation, Authorization and Restriction of Chemicals; EPA-TSCA is the United States Environmental Protection Agency program under the Toxic Substance Control Act; CSCL is the Japanese Chemical Substance Control Law.

I have been pleased to serve on the Assurance Group for the Tire Industry Project for many years because it reinforces my view that the private sector can successfully tackle complex sustainability problems, using sound science within a cooperative framework. I have been particularly impressed with the work done to develop unique chemical markers and innovative sampling methods to help understand the generation, movement and ultimate fate of tire wear particles. This was challenging, groundbreaking work, which has provided valuable information on important ecological aspect of vehicles and tires.

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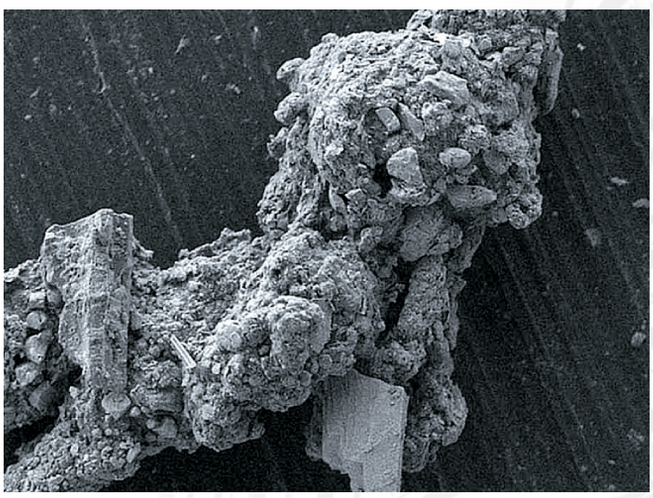
generated as tires move over the roads?" "Do these particles create any exposure or health concerns?" The TIP's initial work examined the availability and quality of existing data about these particles and found there was no data to answer these questions. There was not even agreement on what these particles are made of or a clear idea of how to collect, count and evaluate them.

The particles themselves are not simply rubber pieces from the tire, but rather an agglomeration of material from the tire combined with material from the road, including metal particles, oil, dust, pollen, etc. Hence, we refer to them as tire and road wear particles (TRWP). (See Figure 4.)

Figure 4. Tire and Road Wear Particles (TRWP) (magnified 2756 times)

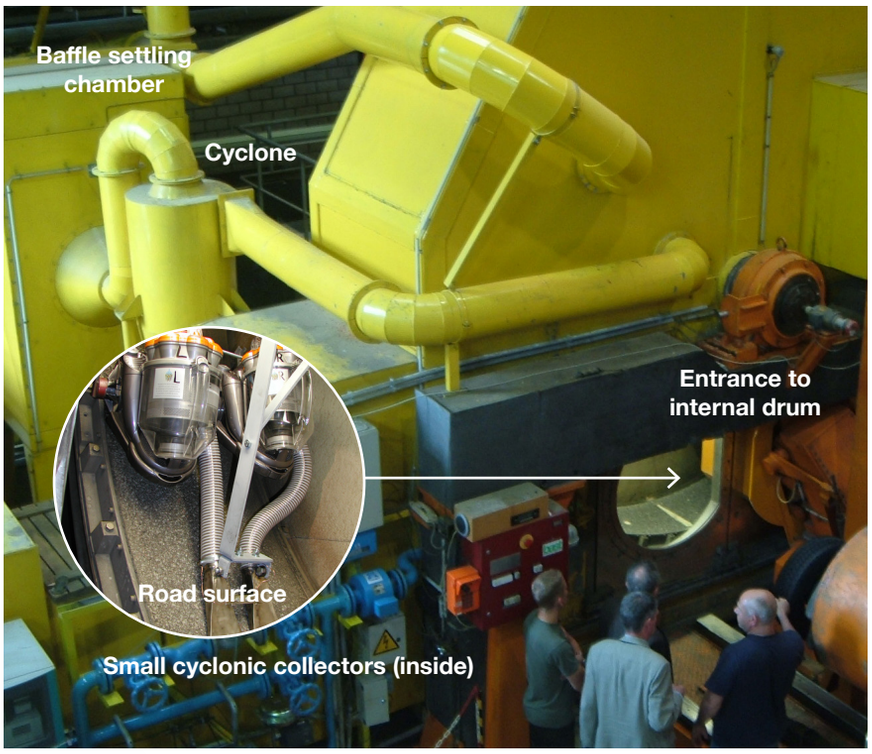


There are also legitimate concerns about the techniques previously used to identify and study these particles. There were no existing global standards for analytical techniques or collection methods for TRWP. The TIP had to develop these.

The TIP began research in 2006 to collect, characterize and understand the composition and movement of these particles, along with their potential impact on both human health and the environment. Part of the program included producing and collecting TRWP in a controlled laboratory setting, using a variety of road surfaces,[3] and analyzing the particles collected. TIP applied this new knowledge about TRWP to additional biological and ecological studies. In other studies, TIP collected particles by sampling air, water and soil near active roadways. Our results to date include:

[3] See http://www.bast.de/EN/BASt/BASt_node.html for details of the facility. BASt is the German Federal Highway Research Institute

Figure 5. BASt Equipment for Making and Collecting TRWP



- TRWP, [3] (Figure 5) (collected at a German government research facility) showed no evidence of aquatic toxicity from fresh or aged particles;
- An inhalation study in rats showed no adverse effects from inhalation exposure to TRWP;
- Extensive air sampling near and around roads in the US, Japan and Europe and the subsequent testing of those samples determined that TRWP are not expected to pose a risk to humans or the environment;
- The air sampling work provided the most definitive information to date for identifying the contribution of TRWP to urban and suburban air pollution.

3. Recycling, Reuse and Recovery of End-of-Life Tires (ELT)

Today, one billion tires reach the end of their useful lives every year. Recovering end-of-life tires (ELT) reduces waste and provides a fuel and material resource that can replace other scarce natural resources (Figure 6). Cooperation between tire manufacturers, retailers and governments is essential if ELT are to be managed sustainably [4]. Some tires are simply abandoned, but many more are recovered and reused in the major developed markets. In fact, tires are one of the most heavily recycled consumer products, with recovery rates of about 85% in well-developed markets (Figure 7).

Following strong interest from external stakeholders, TIP companies developed a summary report on ELT

Figure 6. Recycling Tires to Recover Energy and Materials

[4] Differing government policies assign different roles and payment systems to the tire manufacturer, distributor and consumer. Close cooperation helps ensure maximum recovery of used tires at minimum cost.

Figure 7. Recycling Rates for Consumer Products

Recycling and recovery rates for ELT are generally far higher than for most other consumer goods			
Estimated recycling rate in %			
Item \ Region	**Europe**	**US**	**Japan**
Tires	84	86	85
Glass	65	22	99
Car batteries	90 (UK)	99	-
Steel containers	63	63	88
Aluminum beverage cans	52	52	92
PET bottles	39	24	66
Paper/cardboard	64	50	66

See Table 1, page 5 Managing End-of-Life Tires, Full Report. www.wbcsd.org/tires/elt-publications.aspx

in 2008. The report – *Managing End-of-Life Tires* – outlines what they are, their potential environmental impact, and actions necessary to ensure proper management.

Following this publication, an ELT Working Group collected additional data on ELT management, recovery (rates and uses), legislation, stockpile status and costs from key markets around the world. The TIP used this information (in collaboration with industry associations from Europe, Japan, Korea and the US) to develop a manual for effective ELT management systems – *ELT: A Framework for Effective Management Systems* [5].

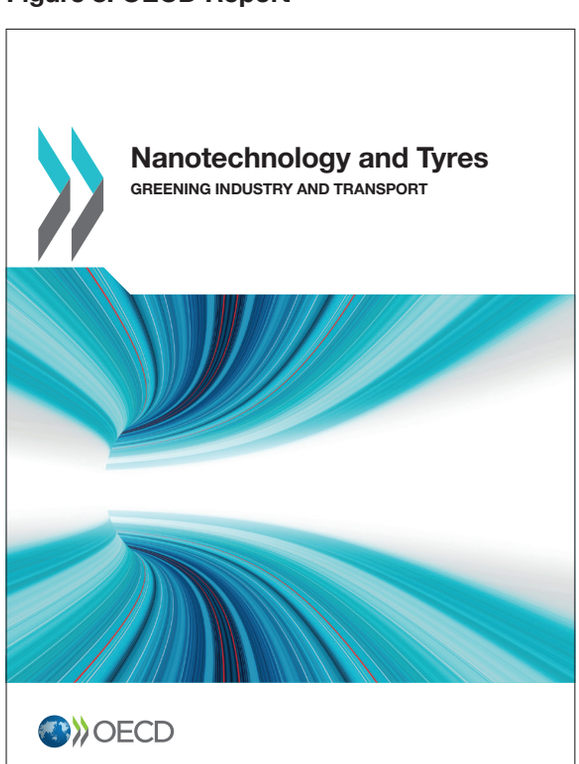
The ELT manual is built on successful experience in countries and regions where ELT management systems have been used for many years. The manual has been distributed within TIP companies and through national tire manufacturers' trade associations in many countries. As tire production and use grow in developing economies, the manual should help improve ELT management in places where there is currently little or no ELT management experience.

The TIP is also actively involved in promoting effective ELT management in the many countries around the world where they operate. They have recently begun discussions with their Chinese counterparts, as China now has the world's largest automotive market and will soon be faced with large numbers of ELT.

4. Working with nanomaterials

Nanomaterials offer unique properties for many promising applications and products, including those that can improve tires and the transport sector. Early research shows they have the potential to decrease rolling resistance (reducing fuel consumption and CO_2 emissions) and lower wear (increasing tire lifetime and reducing materials use) while maintaining wet grip and existing safety levels.

Figure 8. OECD Report



[5] See www.wbcsd.org/tires/elt-publications.aspx

Today, nanomaterials are used in a variety of products, including cosmetics and packaging. Yet some have raised concerns about the environmental, health and safety impacts of these nanomaterials. The TIP is addressing these concerns for tires by characterizing potential worker exposures in manufacturing plants and developing a framework and relevant tools to help guide decision-making – tools to assess the economic, social and environmental impacts of introducing new nanomaterials.

In an effort to understand the potential for exposure to nanosized particles during the manufacture of a tire, the TIP researched methods to identify and measure carbon black and silica nanoparticles in workplace air. The method that the TIP ultimately developed will help future risk assessments of these materials as well as provide a method for other nanomaterials that might be used.

Between 2012 and early 2014, TIP worked with the Organisation for Economic Co-operation and Development (OECD) to evaluate the societal benefits of, and identify best practices for, the development and use of new nanomaterials in tires. The OECD published their report (Figure 8)[6] in July 2014. They concluded that the use of new nanomaterials in tire production could improve the sustainability of the tire industry and reduce the environmental impacts of vehicles. The OECD report recognizes that the potential environmental, health and safety risks of the new nanomaterials have to be carefully managed. It also encourages setting industry specific guidelines for using these materials.

The future

The TIP companies have built a successful platform within WBCSD to research, understand and develop solutions to global tire industry issues dealing with health and the environment. In most cases, these are issues where a single company working alone would be unlikely to have a significant impact, but where joint action from a significant part of the industry can truly make a difference. Where does the TIP go from here?

Tire production and use are expected to more than double in the next 30 years, with much of this growth in developing economies. The TIP continues as an open platform to evaluate expanding its presence and membership in developing markets where tire production is growing most rapidly and environmental, health and safety practices are still being defined.

The TIP has always sought to help improve the industry's environmental performance. Toward that end, the TIP has developed a draft set of Product Category Rules (PCR) for certain tires and that draft is now available for public comment. Once these rules are piloted and published, they will form a basis to develop an Environmental Product Declaration (EPD) for tires, using International Organization for Standardization (ISO) guidelines[7]. EPDs provide a transparent, consistent analysis of the life-cycle impacts of a product. The TIP is also evaluating a number of potential key environmental, health and safety (EH&S) performance indicators for TIP members (and others who may wish to use them). We expect our strong, 10-year partnership will enable us to be proactive and successfully address these and other issues as we move forward.

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[6] OECD (2014), *Nanotechnology and Tyres: Greening Industry and Transport*, OECD Publishing. http://dx.doi.org/10.1787/9789264209152-en

[7] See ISO standard 14025, which sets the principles and procedures for developing EPDs.

TIP publications and presentations

In addition to publications from the World Business Council for Sustainable Development, a number of peer-reviewed scientific articles have appeared in the literature derived from the TIP research work over the past ten years. Selected publications and conference presentations are listed below.

Selected WBCSD Publications and Commissioned Studies

1. *TRWP Global Sampling Project Summary Report,* (2011)

2. *State of Knowledge report* (July 2008)

3. *End-of-Life Tires: A Framework for Effective Management Systems* - Full report (June 2010)

4. *Report on Literature Search and Review Conducted on Behalf of Tire Industry Project Nanomaterials Working Group* (October 2011)

5. *Managing End-of-Life Tires* (November 2008)

Selected Peer-Reviewed Publications and Conference Presentations

1. Kreider M.L., W.D. Cyrs, M.A. Tosiano, and J.M. Panko. 2015. "Evaluation of quantitative exposure assessment method for nanomaterials in mixed dust environments: Application in tire manufacturing facilities," Annals of Occupational Hygiene, Advance online publication, July 23, 2015. doi: 10.1093/annhyg/mev052.

2. Unice K.M., JL. Bare, ML. Kreider, JM. Panko. 2015 "Experimental methodology for assessing the environmental fate of organic chemicals in polymer matrices using column leaching studies and OECD 308 water/sediment systems: Application to tire and road wear particles," Science of the Total Environment 533 (2015) 476–487.

3. Unice, K.M., M.L. Kreider, and J.M Panko. 2013. "Comparison of tire and road wear particle concentrations in sediment for watersheds in France, Japan, and the United States by quantitative pyrolysis GC/MC analysis," Environmental Science & Technology, 47(15):8138-8147.

4. Panko, J.M, J. Chu, M.L. Kreider, and K.M. Unice. 2013. "Measurement of airborne concentrations of tire and road wear particles in urban and rural areas of France, Japan, and the United States," Atmospheric Environment, 72:192-199.

5. Unice, K.M., M.L. Kreider, and J.M. Panko. 2012. "Use of a deuterated internal standard with pyrolysis-GC/MS dimeric marker analysis to quantify tire tread particles in the environment," International Journal of Environmental Research and Public Health, 9:4033-4055.

6. Kreider, M.L., M. Doyle-Eisele, R.G. Russell, J.D. McDonald, and J.M. Panko. 2012. "Evaluation of potential for toxicity from subacute inhalation of tire and road wear particles in rats," Inhalation Toxicology, 24(12):907-917.

7. Panko, J.M., M.L. Kreider, B.L. McAtee and C. Marwood. 2012. "Chronic toxicity of tire and road wear particles to water- and sediment-dwelling organisms," Ecotoxicology, Advance online publication, September 21, 2012. doi: 10.1007/s10646-012-0998-9.

8. Marwood C., B.L. McAtee, M.L. Kreider, R.S. Ogle, B.L. Finley, L.I. Sweet and J.M. Panko. 2011. "Acute aquatic toxicity of tire and road wear particles to alga, daphnid and fish," Ecotoxicology, Advance online publication, July 26, 2011. doi: 10.1007/s10646-011-0750-x.

9. Kreider, M.L., J.M. Panko, B.L. McAtee, L.I. Sweet and B.L. Finley. (2009) "Physical and Chemical Characterization of Tire-Related Particles: Comparison of Particles Generated Using Different Methodologies," Science of the Total Environment, 2010 Jan 1;408(3):652-9

10. Panko, J.M., J. A. Chu, M. L. Kreider, B. L. McAtee and K, M. Unice, "Quantification of tire and road wear particles in the environment." Urban Transfort, A Coruña, Spain, 15 May 2012.

11. Panko, J. M., M.L. Kreider, L.I. Sweet, B.L. McAtee and B.L. Finley. "Methods for Collecting Tire Wear Particles." Paper #40. Fall 174th Technical Meeting of the Rubber Division of the American Chemical Society, October 2008, Louisville, KY.

12. Kreider, M.L., B.L. McAtee, L.I. Sweet, J.M. Panko and B.L. Finley. "Physical and Chemical Characterization of Tire-Related Particles: Comparison of Particles Generated Using Different Methodologies." Paper #41. Fall 174th Technical Meeting of the Rubber Division of the American Chemical Society, October 2008, Louisville, KY.

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) is a CEO-led organization of forward-thinking companies that galvanizes the global business community to create a sustainable future for business, society and the environment. Together with its members, the Council applies its respected thought leadership and effective advocacy to generate constructive solutions and take shared action. Leveraging its strong relationships with stakeholders as the leading advocate for business, the Council helps drive debate and policy change in favor of sustainable development solutions.

The WBCSD provides a forum for its 200 member companies - which represent all business sectors, all continents and a combined revenue of more than $7 trillion - to share best practices on sustainable development issues and to develop innovative tools that change the status quo. The Council also benefits from a network of 60 national and regional business councils and partner organizations; a majority of which are based in developing countries.

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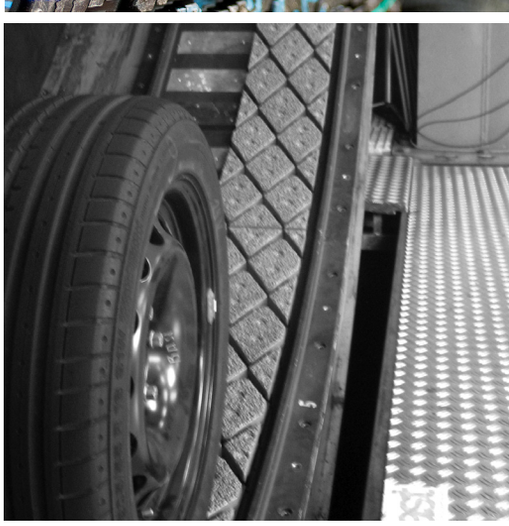

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