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## Is artificial turf hiding an 800 pound gorilla?

Could exposure and inhaling carbon black nanoparticles and carbon nanotubes found in pulverized tires and the tire crumb used on artificial turf fields be as harmful as breathing **ASBESTOS**?

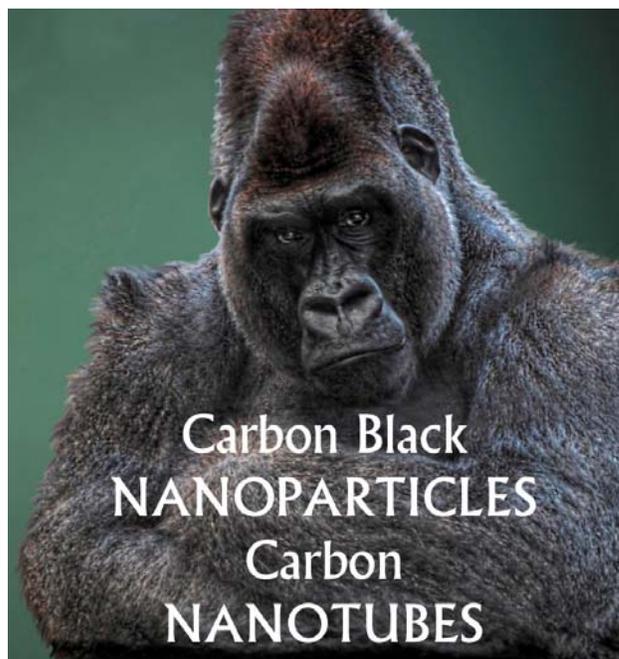
By Jim Novak  
Turfgrass Producers International

I'm not a big fan of articles that pose a lot of questions and offer few, if any, answers. Listening to conspiracy theories, hearing "what if" scenarios, or reading articles that make unfounded claims and present mere speculation often do little more than ruffle the feathers of a few people and enrage others.

The debate over the health safety of synthetic turf fields has gone back and forth for years. Concerns about toxic metals, silica sand, staph infections, dangerously high surface temperatures, proper methods of disposal, etc., are just a few of the significant issues that have come under scrutiny.

However, there are times when information comes to light that requires broader attention. Such is the case with a growing concern expressed by many health care professionals and research scientists regarding the possible health consequences of carbon black nanoparticles present in tires that make up tire crumb; the most common infill used on artificial turf fields.

Nanoparticles are particles less than 100 nanometers in diameter. A nanometer is a billionth of a meter, about the size of six carbon atoms in a row.



For comparison a human hair, is about 80,000 nanometers wide and a strand of DNA is two nanometers wide. To visualize it another way, a nanometer is to one inch as one inch is to 400 miles.

Whether you are for or against artificial turf this subject is important; especially if you have children who play on artificial turf fields or visit playgrounds that use tire crumb for cushioning; or if you are a student or professional athlete who plays football, soccer, rugby, lacrosse or baseball on fields that use tire crumb as an infill.

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Nanoparticles and tire crumb (cont'd from page 1)

**THE CONCERN** — Carbon black nanoparticles make up 30% or more of car tires; the same tires that are pulverized for creating the tire crumb used on artificial turf playing fields and on playgrounds for children. Engineered carbon nanotubes and other engineered nanoparticles (zinc, titanium, etc.) are often made in specific shapes to give added strength and durability to tires and other goods. It is the long thin nature of engineered carbon nanotubes that has some scientists drawing a comparison between the possible health hazards of tire crumb with asbestos.

## How do carbon nanotubes affect lung tissue?

In May of 2008 in an article by Larry Greenemeier for *Scientific American* he quoted one study that went so far as to suggest, **“Inhaling carbon nanotubes could be as harmful as breathing asbestos.”**

The study Greenemier referenced was posted by *Nature Nanotechnology* led by the Queen’s Medical Research Institute at the University of Edinburgh/MRC Center for Inflammation Research in Scotland. Their research showed that long, needle-thin carbon nanotubes could lead to lung cancer and inhaling carbon nanotubes could be as harmful as breathing asbestos.

A carbon nanotube is a carbon molecule that resembles a cylinder made out of chicken wire that is one to two nanometers in diameter by any number of millimeters in length. Nanotubes have a tensile strength 10 times greater than steel and they are considered the strongest material for their weight known to mankind. It should be noted that carbon black is a natural although manufactured material made up of carbon nanoparticles, carbon nanotubes are created/engineered by scientists and are much rarer although apparently highly toxic at low concentrations.

The study suggested that inhaling carbon nanotubes could lead to the same cancer and breathing problems that prompted a ban on asbestos as insulation in buildings.

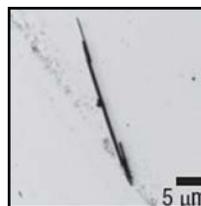
The research scientists observed that long, thin carbon nanotubes look and behave like asbestos fibers, which have been shown to cause mesothelioma, a deadly cancer of the membrane lining the body’s internal organs (particularly the lungs) and can take 30 to 40 years to appear following exposure.

Asbestos fibers are especially harmful, because they are small enough to penetrate deep into the lungs yet too long for the body’s immune system to destroy. Just how small are carbon nanotubes? They are no thicker than an atom, or one billionth of a meter wide, or approximately 10,000 times smaller than a human hair.

Andrew Maynard, the study’s co-author and chief science advisor for the Woodrow Wilson International Center for Scholar’s Project on Emerging Nanotechnologies based in Washington, D.C. has been researching and warning of the potential health and environmental risks of carbon nanotubes since 2003 and is quoted as saying there had been no coordinated effort to date to analyze the findings of carbon nanotube toxicity studies.

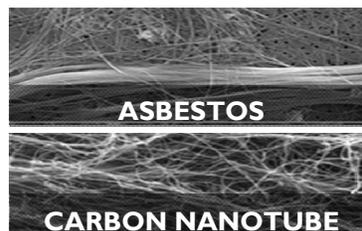
Since the initial release of the MRC study other researchers have expressed their concerns as well. The *National Institute for Occupational Safety and Health* (NIOSH) reported their research methods demonstrate that breathing nanoparticles may result in damaging health effects.

NIOSH scientists invented a way to suspend nanotubes in the air so the concentration of particles could be carefully controlled. Mice were placed into a carefully controlled environment where they could breathe the air containing the particles. Scientists studied the effects of exposure after 1, 7, and 28 days. The research showed that carbon nanotubes were more potent when inhaled than when aspirated. In addition, the research showed early indications of serious health outcomes that may have longer term effects such as cancer, and therefore, ongoing research is important to more clearly understand the implications of exposure to carbon nanotubes.



### Carbon Nanotube:

Researchers studied multiwalled carbon nanotubes comprising anywhere from two to 50 cylinders concentrically stacked with a common long axis. Image: Courtesy of the University of Edinburgh/MRC Center for Inflammation Research



### Dangerous similarity:

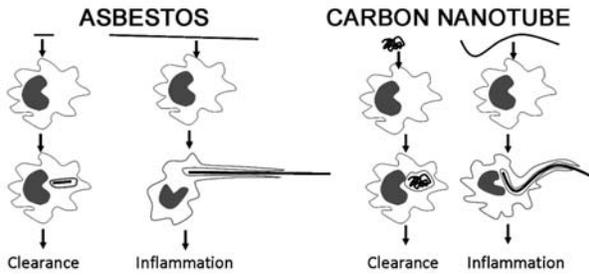
Asbestos (top) and long, multi-walled nanotubes (bottom) cause similar chronic inflammation in mice. Image: C. A. Poland et al., University of Edinburgh

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Nanoparticles and tire crumb (cont'd from page 2)

In May 2008, *Nature Nanotechnology* reported a similar finding, “Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study.”

The study reported, “Carbon nanotubes have distinctive characteristics, but their needle-like fiber shape has been compared to asbestos, raising concerns that widespread use of carbon nanotubes may lead to mesothelioma, a cancer of the lining of the lungs similar to that caused by exposure to asbestos.



Source: Donaldson et al. Particle and Fibre Toxicology 2010 7:5

Exposing the mesothelial lining of the body cavity of mice, as a surrogate for the mesothelial lining of the chest cavity, to long multi-walled carbon nanotubes results in asbestos-like, length-dependent, pathogenic behavior. This includes inflammation and the formation of lesions known as granulomas. This is of considerable importance, because research and business communities continue to invest heavily in carbon nanotubes for a wide range of products under the assumption that they are no more hazardous than graphite. Our results suggest the need for further research and great caution before introducing such products into the market if long-term harm is to be avoided.”

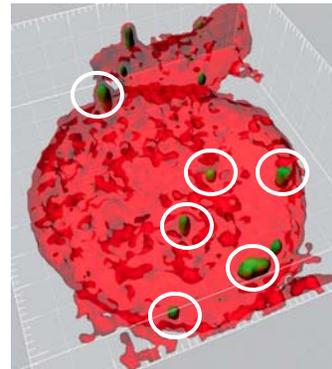
Source: Nature Nanotechnology 3, 423 - 428 (2008) Published May 20, 2008 | doi:10.1038/nano.2008.111.

## How do carbon black nanoparticles get to brain tissue?

Peter Gehr, a professor of Histology (the study of tissue) and Anatomy at the University of Bern in Switzerland stated that synthetic nanoparticles can penetrate tissue and cells, and spread throughout the body – even to the brain.

Gehr is astonished that potential health risks of synthetic nanoparticles are barely acknowledged outside the scientific world and government agencies. “If nanoparticles are not solidly bound to another material, there is a risk that we could inhale them. They can enter the bloodstream and spread throughout the entire body. The mere fact that particles penetrate into the body is a problem.”

Source: Natural resources in Switzerland – Environment - Nanotechnology 3/20/2010, Federal Office for the Environment



Nanoparticles can penetrate into tissue and cells, and spread throughout the body via the bloodstream. This enlarged image of red blood cells, which was produced at the University of Bern, Institute of Anatomy, using a laser scanning microscope, shows green nanoparticles that have penetrated the cells. Photo: Barbara Rothen-Rutishauser, Institute of Anatomy, University of Bern

### Carbon black — tires — tire crumb — artificial turf playing field.



Carbon black is added during tire manufacturing and make up approximately 30% of the final product.



Millions of used tires are recycled to create tire crumb.



The New York State Department of Public Health reports that tire crumb pellets from tires range in size from about one-sixteenth to one-quarter inch in diameter and are typically applied at a rate of two to three pounds per square foot of field's surface.



Tire crumb is the most common infill on synthetic turf fields.

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Nanoparticles and tire crumb (cont'd from page 3)

## Carbon Black Nanoparticles — What about the children?



Environment and Human Health, Inc. has asked the following questions about nanoparticles in the tire crumb infill used as mulch for playgrounds used by children:

- (1) How does the knowledge that carbon black nanoparticles are added to rubber tires affect the risk assessments done on synthetic turf and the rubber mulch used in toddlers' playgrounds?

- (2) Because none of the risk assessments done up to the present time on rubber tire crumbs or playground mulch have taken into consideration the fact that carbon black nanoparticles have been added to rubber tires -- how does this fact affect the claim by some states that rubber tire crumbs and rubber tire playground mulch are safe for children to play on?
- (3) As children play on synthetic turf fields and playground mulch - dust develops. Are nanoparticles in the dust? If so, are they capable of being aspirated into the children's lungs? Who is researching this? Rubber tires are designed for cars and trucks - they were never designed for grinding up and putting where children play. How does this fact affect some states approvals for putting used tire crumb where children play?
- (4) Could this be another example of a toxic material getting out into the environment without enough testing?

Environment and Human Health, Inc. (EHHI) is a nine-member, non-profit organization composed of doctors, public health professionals and policy experts. The organization is dedicated to protecting human health from environmental harms through research, education and the promotion of sound public policy. EHHI is committed to improving public health and reducing environmental health risks to individuals.

## 2008–2009 Annual Report—President's Cancer Panel

“Nanomaterials can be extremely toxic, and despite their promise, concern is growing about their potential health and environmental risks. Because of their structure and small size, they can be inhaled, ingested, and absorbed through the skin, entering the blood stream, penetrating cells throughout the body (including the brain), and perhaps interfering with DNA processes.(1)

In August 2009, seven young Chinese women suffered permanent lung damage and two of them died after working for months without adequate protection in a paint factory using nanoparticles.(2)

Once inhaled, nanoparticles that penetrate pulmonary epithelial cells or aggregate around red blood cell membranes cannot be removed.(3)”

**SOURCE: 2008–2009 Annual Report—President's Cancer Panel  
REDUCING ENVIRONMENTAL CANCER RISK  
What We Can Do Now**

[http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP\\_Report\\_08-09\\_508.pdf](http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf)

1. Nudelman J, Taylor B, Evans N, Rizzo R, Gray J, Engel C, Walker M. Policy and research recommendations emerging from the scientific evidence connecting environmental factors and breast cancer. *Int J Occup Environ Health*. 2009;15:79-101.
2. Lyn TE. Deaths, lung damage linked to nanoparticles in China [Internet]. *News Daily*. 2009 Aug 19 [cited 2009 Nov 7]. Available from: <http://www.newsdaily.com/sotries/tre57ily7-us-china-nanoparticles/>.
3. Song Y, Li X, Du X. Exposure to nanoparticles is related to pleural effusion, pulmonary fibrosis, and granuloma. *Eur Resp J*. 2009;34(3):559-67.

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Nanoparticles and tire crumb (cont'd from page 4)



## “Carbon black is the proverbial 800 pound gorilla in the room that no-one wants to talk about . . .”

Perhaps neuroscientist, Dr. Kathleen Michels summarized it best:

“Carbon black is the proverbial 800 pound gorilla in the room that no-one wants to talk about, or take notice of, but it has the potential to wreck everything in its path. First, It has been declared a possible carcinogen by the US government and by the World Health Organization. Then, carbon black used in tires consists of the purest, smallest (ultrafine) nanoparticles giving them a unique potential toxicity throughout the body.

“Normally this might not be a problem for any individual, since most of the carbon black is trapped inside a tire. However, when you pulverize tires for use in children’s playing fields, whether done at ambient or cold temperatures- everything in them (including carbon black particles) becomes more available to interact with the environment and people since the surface area to volume \* increases exponentially as you go from whole tire, to pulverized tire granule to the dust that becomes airborne with weathering and the impact of each child’s footfall and body. Finally, the sheer concentrated volume of this pulverized carbon black material should get serious attention: tires are 30% or more carbon black so a 200 ton tire-crumb laden sports field contains around 60 TONS of carbon black. An unprecedented exposure that deserves serious attention and research.

“But carbon black is not the only nanoparticle containing component of tires. Engineered nanoparticles \*such as carbon nanotubes, which may have asbestos like toxicity, are also being added to tires. But how much and to which tires is difficult to determine. Which highlights a main problem with tire crumb: the recipe of any \*company’s tires is proprietary so we never know exactly what the ingredients are for any individual tire much less a bag of tire crumb (and even less the 30,000 or so tires in a sports field!).

Some schools which have tire crumb on fields or playgrounds close to their classrooms report a fine gray dust on school surfaces inside when windows are open. Most artificial turf fields with tire crumb are still relatively young. There is no evidence yet of long – term harm from this unprecedented, often chronic, exposure of children to carbon black or other tire components from playing on tire crumb ; but then again there are no studies on children exposed chronically to tire crumb over time. But there are worrying studies on exposure to carbon black particles in the air. Shouldn’t we be asking the questions and following up on the exposed children with research?”

- Dr. Kathleen Michels

### **IMPORTANT:**

There are different types of nanoparticles made of different building blocks and each type of nanoparticle can be unique in its actions and effects, and act differently in engineered products as well as in the body.

It is true that frequent exposure to nanoparticles from many consumer products means some nanoparticles are getting into us.

It is also true that cell studies suggest that some types of nanoparticles can damage the DNA or cause cell death in different parts of the body, such as the brain, the lungs or blood vessels.

The term “nanoparticle” is not intended to apply to all nanoparticles but in this case carbon black nanoparticles.

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Nanoparticles and crumb rubber (cont'd from page 5)

**“People either have no idea about nanoparticles or do not regard them as a problem. The potential risks are also of little interest at the political level. People are simply not reacting to the possible harmful aspects of synthetic nanoparticles right now. The mere fact that particles penetrate into the body is a problem, but this is barely acknowledged outside the realms of science and government agencies.”** - Dr. Peter Gehr, Professor of Histology and Anatomy at the University of Bern

The comments expressed on the previous pages were based on research reports and articles from numerous healthcare organizations, research scientists, health care professionals and nanotechnology experts who represent a wide variety of non-biased and reputable sources. Because the subject matter is likely to stir interest and create some controversy we have provided a partial list of numerous reference materials so readers can reach their own conclusion. — J. Novak

#### Study Says Carbon Nanotubes as Dangerous as Asbestos

New research shows long, needle-thin carbon nanotubes could lead to lung cancer.  
Scientific American  
<http://www.scientificamerican.com/article.cfm?id=carbon-nanotube-danger>

#### Association of Black Carbon with Cognition among Children in a Prospective Birth Cohort Study

Harvard School of Public Health published in American Journal of Epidemiology  
<http://aje.oxfordjournals.org/content/167/3/280.full>

#### As Nanotech's Promise Grows, Will Puny Particles Present Big Health Problems?

Amid the great promise nanotechnology offers, big questions remain on health dangers posed by exposure to tissue-penetrating particles.  
Scientific American  
<http://www.scientificamerican.com/article.cfm?id=will-nano-particles-present-big-health-problems>

#### How dangerous are carbon nanoparticles?

Fraunhofer Institute for Toxicology and Experimental Medicine  
<http://www.item.fraunhofer.de/en/press-media/latest-news/pm-carbonblack.jsp>

#### NIOSH Research Methods Demonstrate that Breathing Nanoparticles May Result in Damaging Health Effects

National Institute for Occupational Safety and Health  
<http://www.cdc.gov/niosh/docs/2010-158/pdfs/NanotechParticles.pdf>

#### Acute Pulmonary Response of Mice to Multi-Wall Carbon Nanotubes

Inhalation Toxicology, 22(4): 340-347 (March 2010)  
[http://www.nanolawreport.com/In\\_Vivo\\_Abstracts\\_part\\_45.pdf](http://www.nanolawreport.com/In_Vivo_Abstracts_part_45.pdf)

#### Carbon Black

Wisconsin Department of Public Health  
<http://www.dhs.wisconsin.gov/eh/chemfs/fs/carblack.htm>

#### Grappling With The “Gray Zone,” Feds Focus on Nano Workers’ Health

New Haven Independent  
[http://www.newhavenindependent.org/index.php/archives/entry/grappling\\_with\\_the\\_gray\\_zone/](http://www.newhavenindependent.org/index.php/archives/entry/grappling_with_the_gray_zone/)

#### Multi-Walled Carbon Nanotubes—Significant New Use Rule

Environmental Protection Agency  
<http://www.gpo.gov/fdsys/pkg/FR-2011-05-06/pdf/2011-11127.pdf>

#### Frustrated phagocytes and the fibre paradigm

Diamond Environmental Ltd independent Health, Safety and Training consultancy.  
<http://diamondenv.wordpress.com/2011/04/15/frustrated-phagocytes-and-the-fibre-paradigm/>

#### Nanotechnology's Public Health Hazard?

Science Now  
<http://news.sciencemag.org/sciencenow/2008/05/20-01.html>

#### Carbon Nanomaterials: Fine for Fly Food, Bad for Fly Coating

Scientific American  
<http://www.scientificamerican.com/article.cfm?id=carbon-nanomaterials-bad-for-fruit-fly-coating>

#### Synthetic Athletic Fields - A Question of Ingestion

The City of San Francisco City Fields Foundation  
<http://www.youtube.com/watch?v=8zsodulEmz0>

#### Inhaled Carbon Nanotubes Reach Subpleural Tissue in Mice

Nature Nanotechnology, 4(11): 747-751  
[http://www.nanolawreport.com/In\\_Vivo\\_Abstracts\\_part\\_41.pdf](http://www.nanolawreport.com/In_Vivo_Abstracts_part_41.pdf)

#### Nanoparticles Induce Changes of the Electrical Activity of Neuronal Networks on Microelectrode Array Neurochips

Environmental Health Perspectives  
<http://ehp03.niehs.nih.gov/article/submitArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.0901661>

#### Toxic Potential of Materials at the Nanolevel

Science 3 February 2006:  
Vol. 311 no. 5761 pp. 622-627 DOI: 10.1126/science.1114397  
<http://www.sciencemag.org/content/311/5761/622.abstract>

#### YouTube VIDEO — “Toxic Chemicals: The Safety of Synthetic Fields and How Environmental Laws are Failing Our Children” — 9:40 into nanoparticles

Speaker: Dr. Joel Forman, Associate Professor of Pediatrics and Community and Preventive Medicine, Mt. Sinai School of Medicine and other researchers offer their latest findings on the potential health and environmental risks associated with crumb rubber in-fill used on synthetic turf fields. Panel: Dr. Susan Buchanan, Clinical Assistant Professor, Environmental and Occupational Health Sciences, University of Illinois Chicago; Dr. Helen Binns, Professor in Pediatrics and Preventive Medicine, Children Memorial Hospital Chicago and Carolyn Raffensperger, Environmental lawyer and Executive Director of Science and Environmental Health Network.  
<http://www.findallvideo.com/toxic-chemicals-safety-synthetic-fields-how-environmental-laws-are-failing-our-children-pt-02/id/3325988535>

#### Induction of Inflammation-dependent Pyroptosis by Carbon Black Nanoparticles

The Journal of Biological Chemistry  
<http://www.jbc.org/content/286/24/21844>

#### Nanoparticles can penetrate brain tissue

Interview with Dr. Peter Gehr, Professor of Histology (the study of tissue) and Anatomy at the University of Bern in Switzerland by the Federal Office for the Environment (the Swiss federal government's center of environmental expertise) Dr. Gehr is internationally renowned as a researcher and for his studies on the behavior of nanoparticles in the lungs and on their interaction with cells.  
<http://www.bafu.admin.ch/dokumentation/umwelt/10649/10659/index.html?lang=en>