

If I had asked people what they wanted,
they would have said faster horses.

Henry Ford (1863–1947)

INDOOR AIR QUALITY

Scented Products Emit a Bouquet of VOCs

A survey of selected scented consumer goods showed the products emitted more than 100 volatile organic compounds (VOCs), including some that are classified as toxic or hazardous by federal laws.¹ Even products advertised as “green,” “natural,” or “organic” emitted as many hazardous chemicals as standard ones.

Anne Steinemann, a professor of civil and environmental engineering and public affairs at the University of Washington, Seattle, and colleagues used gas chromatography–mass spectrometry to analyze VOCs given off by the products. They tested 25 air fresheners, laundry detergents, fabric softeners, dryer sheets, disinfectants, dish detergents, all-purpose cleaners, soaps, hand sanitizers, lotions, deodorants, and shampoos. Many of the products tested are top sellers in their category.

A single fragrance in a product can contain a mixture of hundreds of chemicals, some of which (e.g., limonene, a citrus scent) react with ozone in ambient air to form dangerous secondary pollutants, including formaldehyde.² The researchers detected 133 different VOCs. Most commonly detected were limonene, α - and β -pinene (pine scents), and ethanol and acetone (often used as carriers for fragrance chemicals).¹

Steinemann and colleagues found the average number of VOCs emitted was 17.¹ Each product emitted 1–8 toxic or hazardous chemicals, and close to half (44%) generated at least 1 of 24 carcinogenic hazardous air pollutants, such as acetaldehyde,

1,4-dioxane, formaldehyde, or methylene chloride.¹ These hazardous air pollutants have no safe exposure level, according to the U.S. Environmental Protection Agency.³ Of the 133 VOCs detected, only ethanol was listed on any label (for 2 products), and only ethanol and 2-butoxyethanol were listed on any Material Safety Data Sheet (for 5 products and 1 product, respectively).¹

The Consumer Product Safety Commission, which regulates cleaning supplies, air fresheners, and laundry products, currently does not require manufacturers to disclose any ingredients on the label, including fragrances in these products.⁴ The same is true for fragrances in personal care items,

which are overseen by the Food and Drug Administration.⁵ The Household Product Labeling Act, currently under review in the U.S. Senate, would require manufacturers to label consumer products with all ingredients, including fragrance mixtures.⁶ “Disclosing all ingredients could be a first step to understanding potential toxicity and health effects,” says Steinemann.

Although the authors did not seek to assess whether use of any of the products studied would be associated with any risk,¹ Steinemann says she receives hundreds of letters, phone calls, and e-mails from people who report a variety of respiratory, dermatological, and neurological problems they attribute to scented products:

“Children have seizures after exposure to dryer sheets, and adults pass out around air fresheners,” she says.⁷ Steinemann and colleague Stanley M. Caress have written elsewhere that 19% of respondents across two U.S. telephone surveys reported health problems they attributed to air fresheners,

and nearly 11% reported irritation they attributed to scented laundry products vented outdoors.⁸

“It’s important to take people’s complaints seriously,” says Steinemann, because “these human experiences are helping to inform science.” One of her next projects will focus on biomarkers of exposure and effect to better understand how fragranced products may cause a range of adverse health effects. “The ultimate goal is to improve public health,” Steinemann says. For now, she recommends cleaning with basic supplies like vinegar and baking soda.

Steinemann’s study “strongly suggests that we need to find unscented alternatives for cleaning our homes, laundry, and ourselves,” says Claudia Miller, an allergist and immunologist at the University of Texas Health Science Center at San Antonio. An expert in chemical sensitivity, or toxicant-induced loss of tolerance, Miller created the Quick Environmental Exposure and Sensitivity Inventory,⁹ a screening tool for chemical intolerance. According to Miller, products intended to keep homes smelling fresh can set people up for a lifetime of chemically induced illness, and repeated exposure to small amounts of household chemicals can trigger symptoms to previously tolerated chemicals.¹⁰ “The best smell is no smell,” Miller says.

Carol Potera, based in Montana, has written for *EHP* since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

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fragrance figures¹

133 unique VOCs identified among 25 products

24 of these are classified as toxic or hazardous under at least one federal law

ONLY 1 of the 133 was listed on any label

ONLY 2 of the 133 were listed on any MSDS

NANOMATERIALS

Examining Nanotech's Clean Energy Promises

Among the many touted benefits of nanotechnology, one of the most alluring is the possibility that it will help reduce reliance on fossil fuels. Researchers and industry analysts foresee lighter and more efficient vehicles and wind turbines, solar panels that capture more of the sun's energy, smaller and longer-lasting batteries, better insulation, and smarter lighting, to name a few nanotechnology prospects, some already on the market. But a new report from the conservation group Friends of the Earth (FOE) criticizes the vision of a clean-energy revolution brought about by engineered nanomaterials as so much greenwash and claims the young technology's carbon, environmental, and human-health footprints are likely to eclipse any energy savings.¹

Engineered nanomaterials are a relatively new class of manufactured materials with at least one dimension between 1 and 100 nm. The larger ones are about one-eightieth the size of a red blood cell. At such small scales, the ratio of surface area to volume is huge, giving the material novel properties. Nanomaterials in an array of shapes and chemistries are being applied to medicine, consumer products, environmental remediation, the energy industry, and more.

The FOE report focuses in part on the enormous amounts of energy needed to produce many nanomaterials. For instance, one life-cycle analysis calculated that carbon nanotubes, which are widely used to strengthen and lighten manufactured goods, require 2–100 times more energy to produce than aluminum, a notorious energy hog.² But some critics of the report question whether the energy it takes to produce nanomaterials torpedoes their overall benefit. In a statement, Jay West, senior director of the Nanotechnology Panel at the American Chemistry Council, said, “[w]hile some nanomaterials may be energy-intensive to produce, such energy expenditures may be more than offset by the energy savings they make possible.” (Requests for comment on the report were declined by the U.S. Department of Energy.)

The FOE report also challenges whether nanotechnology will be able to deliver energy savings promised in a long list of applications quickly enough to make a difference. For instance, it cites several studies showing solar panels made with nanomaterials trail conventional silicon panels in efficiency and durability, and says there's not a moment to spare waiting for nanotechnology to catch up. “With climate change we don't really

have that much time to ameliorate the situation,” says Ian Illuminato, one of the report's authors. Moreover, the FOE report warns that petrochemical companies are investing heavily in nanotechnology in the hope it could double the amount of oil that can be extracted from known oil and gas reserves. It also points out that the manufacturing process for many nanomaterials relies on high inputs of water and solvents and generates hazardous by-products and a great deal of waste.

Yet David Rejeski, director of the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars, says, “Compared with the development times of other technologies, nano is not particularly slow and may even be faster. You could say that it has been moving at a pace that will make it unlikely to offer large-scale solutions to the climate challenge within the next five to ten years. But in ten to twenty years, nano will likely play a much larger role in terms of energy solutions.”

One thing everyone seems to agree on is that cost is a big reason for pursuing nanotechnology in the solar industry. Currently traditional silicon-based solar cells generate energy at a price of about \$1.50–2.00 per watt.³ In order for solar to capture a substantial share of the energy market, however, the cost must go down significantly, and silicon-based panels have little hope of keeping up, says Ashok Sood, president and CEO of Magnolia Solar, a startup company developing nanostructure-based solar cells. He says his company's business model relies on analyses and experimental data showing that such solar cells can meet or beat the efficiency of silicon-based cells, bringing the price per watt down to under \$1.00. “Have they been demonstrated? Partially. Is the potential there? Yes. That's what this is all about,” he says. “If I can do under one dollar a watt, I have a winner.”

There also is general agreement that much more information is needed about the potential human health effects of nanomaterials. The limited evidence to date gives some researchers pause. For example, several mouse studies have shown that carbon nanotubes injected into the abdominal cavity (a surrogate for human mesothelial exposure) or instilled into the trachea behave much like asbestos.^{4,5} Another study showed that nanoscale titanium dioxide administered subcutaneously to pregnant mice caused nerve damage in their offspring.⁶

FOE has been calling for a moratorium on the commercialization of products containing nanomaterials for the past five years, pending regulation to protect against potential threats to public health and the environment. “We

need sound regulation, but unfortunately science and new technology always pose regulatory challenges that our agencies just aren't prepared for. But at the same time, we've got thousands of products [already] on the market,” says Illuminato.

Rejeski believes it's too early to dismiss nanotechnology, especially when there is a research effort devoted to greening the manufacturing process. “People are going to get smarter,” he says. “No company wants to use lots of energy and lots of toxic chemicals to make nanomaterials. But developing environmentally benign processes could take ten or twenty years and much more investment.” In fact, about the same time the FOE report was released, researchers based at the Massachusetts Institute of Technology published a new method for producing carbon nanotubes in the laboratory that they say cuts energy requirements in half and reduces harmful by-products by 90% or more.⁷ However, the FOE report notes that even if tenfold decreases in energy use are eventually achieved, carbon nanomaterials will still be much more energy-intensive to produce than aluminum or steel.¹

Bhavik Bakshi of The Ohio State University in Columbus and TERI University in New Delhi, several of whose life-cycle analyses of carbon nanofibers are cited in the FOE report, believes governments and the nanotechnology industry must quickly and significantly increase investments in greening up both manufacturing and products to avoid repeating mistakes made with earlier innovations, like asbestos and the insecticide DDT. Historically, enthusiasm for the immediate benefits of new technologies has overshadowed consideration of potential problems until they appear years later, says Bakshi, adding, “The bar needs to be set a lot higher when it comes to adopting nanoproducts.”

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INNOVATIVE TECHNOLOGIES

Tobacco Bio-oil Kills Agricultural Pests

Cigarette smoking continues to be the leading cause of preventable death and disease in the United States,¹ but tobacco has potentially beneficial uses as well as deadly ones. Gardeners have long known that homemade mixtures of tobacco and water can kill insect pests. But these homemade brews kill desirable insects, too, and could poison animals that ingest them. Now researchers at the University of Western Ontario are finding new ways to turn tobacco into a more selective eco-friendly pest control agent.²

A team led by chemical engineer Cedric Briens heated finely ground tobacco leaves to 500°C in a vacuum, a process called pyrolysis, then collected the condensate. (Since publishing the paper, the team has found they can use the entire plant—leaves and stalks—which makes it easier and cheaper to harvest the tobacco.) The bio-oil was tested against the Colorado potato beetle (*Leptinotarsa decemlineata*), 11 fungi, and 4 bacteria, all of which are agricultural pests.

The bio-oil blocked the growth of the bacteria *Streptomyces scabies* and *Clavibacter michiganensis* and the fungus *Pythium ultimum*. *S. scabies* causes a common potato scab disease that makes potatoes unmarketable, *C. michiganensis* kills young plants and deforms fruits, especially tomatoes, and *P. ultimum* kills seedlings of eggplant, peppers, lettuce, tomatoes, and cucumbers. The bio-oil also killed 100% of Colorado potato beetles, a resistant pest that can destroy potato crops. The other organisms were unaffected.

Nicotine, a key toxin in tobacco, has known insecticidal properties on its own. But even after removing nicotine from the bio-oil, it still potently killed these few pests.² The authors say the

active components probably include a mixture of phenols with known pesticidal properties working synergistically. They analyzed the bio-oil using gas chromatography–mass spectrometry and note that some of the constituents defy detection. It's possible new pesticidal molecules are being formed in the high heat conditions of pyrolysis. "We do know that no single molecule is effective, and we seem to have discovered a natural cocktail," Briens says.

The probable mixture of active chemicals suggests agricultural pests may not readily develop resistance to the bio-oil. Control of the Colorado potato beetle is especially challenging because the beetle is notorious for its ability to adapt rapidly to new pesticides that are applied.³ "Insecticides that work now will be obsolete in a few years, and we'll need new insecticides," Briens says.

The ability of the bio-oil to target certain agricultural pests could be an asset for future commercialization, because it could spare desirable insects such as honeybees. Some pesticide manufacturers are watching the bio-oil work, but they want to know the active molecules before becoming involved. Then the active components of the bio-oil will require toxicity testing to assess their impact on the environment.

Briens' study "is a logical and efficient approach to identify a useful by-product of tobacco plants, creating a value-added pesticidal fraction," says Joel Coats, a professor of entomology and toxicology at Iowa State University in Ames. "The possibility of discovering a novel pesticidal molecule makes the project very worthwhile."

Carol Potera, based in Montana, has written for EHP since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

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The Beat

by Erin E. Dooley

Report Finds Estimates of Gulf Coast Exposure to Carcinogens Off

The Natural Resources Defense Council reports the FDA underestimated seafood consumption by Gulf Coast residents in developing their June 2010 protocol for determining safe seafood levels of

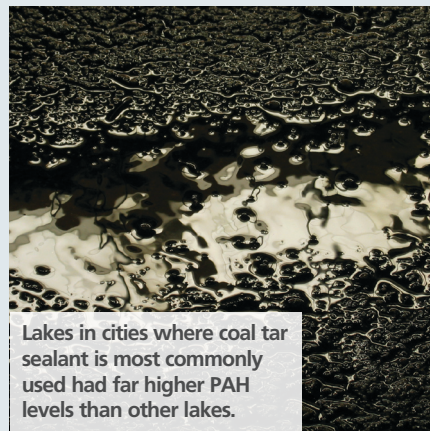


Gulf Coast residents eat an average of two shrimp meals per week, twice the FDA estimate.

toxic PAHs following the BP *Deepwater Horizon* oil spill.¹ The FDA used national consumption data, rather than region-specific information and also did not take into account the dietary patterns of subpopulations including children and the region's large Vietnamese-American population. Gulf Coast shrimp consumption rates were found to range from 3.6 to 12.1 times higher than the FDA estimates.

Federal Bedbug Summit in February

On 1–2 February 2011 the Federal Bed Bug Workgroup will sponsor the second national bedbug summit in Washington, DC.² The meeting will be open to the public and accessible via a webinar. The workgroup will review the current bedbug problem and seeks to identify and prioritize actions to manage and control these increasingly prevalent and resistant pests.



Lakes in cities where coal tar sealant is most commonly used had far higher PAH levels than other lakes.

Coal Tar Sealant a Significant Lake Pollutant

USGS researchers used a chemical mass-balance model to show that coal tar pavement sealants were the chief source of PAHs flowing into 40 U.S. urban lakes.³ Surface water concentrations of PAHs, which are a probable human carcinogen

Left to right: Jjiang Hongyan/Shutterstock; Sean McBride/Stockphoto

CHILDREN'S HEALTH

School Siting: EPA Says Location Matters

Fifty-three million U.S. children and 6 million employees spend much of the day in a public or private school.¹ Pollution problems in these settings are so widespread that the Congress mandated in the Energy Independence and Security Act of 2007 that the U.S. Environmental Protection Agency (EPA) develop model guidelines for choosing healthier sites for new schools. On 17 November 2010, the agency released a draft of its new voluntary guidelines.^{1,2}

About 1,900 new schools were built in the 2008–2009 school year, according to the EPA, continuing a relatively similar construction trend since 2002³ and bringing the total number of public and private schools to about 135,000.¹ The number of existing schools in settings that could be harmful to children is unknown, says Peter Grevatt, director of the EPA Office of Children's Health Protection.

The guidelines are designed mainly for use in siting new primary and secondary (K–12) schools, but the principles behind the guidelines could be adapted for many other existing and new settings where children spend long periods. They cover a wide range of topics, including toxicity on the school site and from nearby properties; other health-related issues such as bicycle and pedestrian access to increase student exercise; maximizing community use of the school; and minimizing disruption of relatively undisturbed environments.

Jason Hartke, vice president of national policy for the U.S. Green Building Council, is generally pleased with the congressional mandate and EPA's actions so far. "There is a strong need for EPA guidelines," he says. "This is another really important tool in the toolbox" for creating healthier schools.

Stephen Lester, science director for the Center for Health, Environment & Justice, also is generally supportive: "There's a lot

of good information in these guidelines." But he says they offer too much wiggle room for allowing schools to be built on toxic sites, such as Superfund properties. He'd rather see language that sanctions such decisions only as a very last resort. That's important, he says, because school districts "never have enough money for monitoring and maintenance," even if the original planning, design, and engineering for mitigating toxicity problems were deemed acceptable. He also would prefer a no-exceptions guideline that directs use of the more-protective cleanup standard for residential use for all school sites.⁴

A broader concern is that many school districts may choose to ignore the voluntary guidelines. Interest in environmental health issues "is very spotty," Lester says, especially when so many other issues—including site availability, zoning, and cost—are high priorities. Even in the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) voluntary certification process for schools,⁵ toxicity issues account for only 10 of the 110 optional points.⁶

The public can comment on the draft guidelines until 18 February 2011. A final version is scheduled for release in late 2011.

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- The LEED baseline criteria stipulate that old landfill sites should be completely avoided and that contamination from other former uses should be cleaned up to meet the most stringent appropriate standard. One point is available for siting a school on a remediated brownfield site, which critics such as Lester say should be done only as a last resort. Nine points are available for reducing vehicle use to lessen emissions or increase student exercise via bicycling or walking. Eight points are available for meeting other site criteria addressed by the EPA guidelines, such as utilizing existing roads and utilities, avoiding 100-year floodplains, protecting or restoring habitat, and encouraging joint community use of school facilities.

and are toxic to fish and other aquatic life, have been increasing in recent decades. Being able to determine the source of these PAHs will help in the design better ways to manage them. Some U.S. municipalities have already banned coal tar sealants.

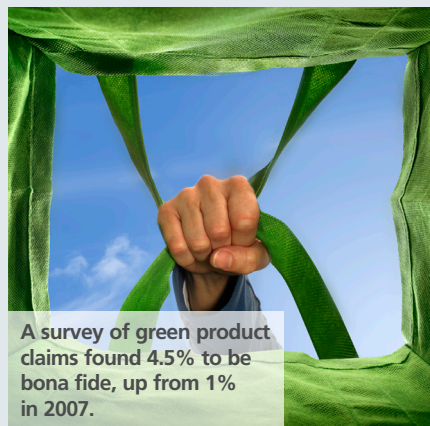
Ford Cottons to Recycling

Ford Motor Company recently announced its 2012 Ford Focus models will use carpet backing and soundproofing materials made from recycled cotton denim.⁴ Cotton production can have a large environmental footprint, and clothing and other textiles represent about 4% of municipal solid waste.⁵ Each car will use an amount of postconsumer cotton equal to the amount in two pair of jeans.⁴

Greenwashing Update

"Greenwashing" is the term for ads and labels that promise more environmental benefit than they deliver.⁶ The third in a series of reports by TerraChoice

Environmental Marketing finds that marketers are getting better at substantiating claims of "greenness" about their products.⁷ The number of self-described green products tallied on shelves increased 73% between 2009 and 2010, with 4.5% of such products making credible claims. In 2007, only 1% of the claims made by surveyed products could be



verified. One area where marketing claims have skyrocketed is in products claiming they have no bisphenol A (up 577% over 2009) or no phthalates (up 2,550% over 2009).

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