

**Nanotechnology:**  
**A universe in Construction**

**President of Brazil**  
Dilma Rousseff

**Ministry of Labour and Employment**  
Manoel Dias

**FUNDACENTRO**

**President**  
Maria Amélia Gomes de Souza Reis

**Substitute Executive Director**  
Erica Lui Reinhardt

**Technical Director**  
Robson Spinelli Gomes

**Administration and Finance Director**  
Paulo César Vaz Guimarães

# **Nanotechnology:** **A universe in Construction**

Motif and Script  
Antonio Gracias Vieira Filho (Tonico)  
IIEP Contributor

Art:  
Vitor Flynn Paciornik



2015

**International Cataloguing in Publication Data (ICPD)**  
**Library and Documentation Service - SDB / Fundacentro**  
**São Paulo – SP - Brazil**  
**Erika Alvez dos Santos - CRB-8/7110**

---

Nanotechnology: A universe in construction/motif and script,  
Antonio Gracias Vieira Filho. - Sao Paulo: Fundacentro, 2015.  
23 p. : Chiefly ill. color; 23 cm - (Nanotechnology comic  
books, n. 3).  
Comic text.

ISBN 978-85-98117-94-2

1 Nanotechnology - Chemical Risk – Comic books.  
I. Vieira Filho, Antonio Gracias. II. Series

CIS Czyma Yc Vekt

CDU 621.039+614.8:544.03(084.1)

---

CIS - Classification of the “Centre International d’Informations de Sécurité  
et d’Hygiene du Travail”

CDU - Universal Decimal Classification

**Fact sheet**

Editorial supervision: Glaucia Fernandes

Proofreading: Karina Penariol Sanches

Illustration: Vitor Flynn Paciornik

Version to English: Infraexperts

Version Revision: Patricia Dias Moura and Maria Ângela Pizzani Cruz

Adequacy of layout: Flávio Barbosa Galvão

# Nanotechnology

## A universe in construction

Dear readers, the Construction Industry historically presents a number of challenges to the health and safety of workers and their workplaces. One of the examples is the construction of major buildings in the early twentieth century, when weren't sought security conditions.



Look! In this photo, the workers are taking a break in a highly dangerous situation. The use of a steel beam for a nap shows that there was no concern with the social areas where workers could stay during their rest time.



The lack of equipment for collective and individual protection stood out in a time marked by the absence of safety measures in the workplace!



Fortunately, since these photos were taken, a lot has changed for the better. These advances have resulted from the mobilization of workers. . .



. . . from the performance of governmental technical institutions, such as Fundacentro, from the supervisory bodies, from construction workers Union...

Mr. Adams, in your homebuilder no worker wears a hard hat! There aren't any available! Only the one you're wearing!

The hard hats are in the laundry, you know?



With the passing of time and the raised awareness of employers themselves...



Now, my homebuilder no longer gets fined! Here, we have a system of risk management!

There are a number of measures and safety equipment that should be adopted in a working site. Collective protection equipment, such as guard rails and trays. . .



. . and personal protective equipment such as hard hats, safety belt, safety glasses and gloves.



With protective equipment and the program Conditions and Working Environment in the Construction Industry, PCMAT, work is safer! And if the hard hat goes with the uniform, you even look fashionable!

But even today, the Construction Industry still concentrates a large number of accidents. This reinforces the need for workers to participate in the Internal Commissions for Accident Prevention!



Workers in construction sites need to talk with their employers and seek better working conditions!

Back to the New Universe Carrier, where our heroes are enjoying their coffee. . .

CIPA MEETING  
13/10 CO

Mr. Anthony,  
what are you  
reading?

Man, an article about the  
struggle of workers in  
construction sites for health  
and safety in their workplace!  
Really good!

Wow, Mr. Anthony.  
.. You are really  
studious! I didn't  
know you were into  
building too!

Actually I got  
interested recently  
because of our next  
job, which is to deliver  
a lot of materials in  
construction sites.

That will be great, for  
sure! I'm already tired  
of just talking about  
nanotech, "nano this,"  
"nano that."

Well, We'll deliver  
many materials.  
.. Pipes, wires,  
tiles. . . But a lot  
of nanocement  
too! And we'll  
talk a lot about  
nanotechnology in  
this story!

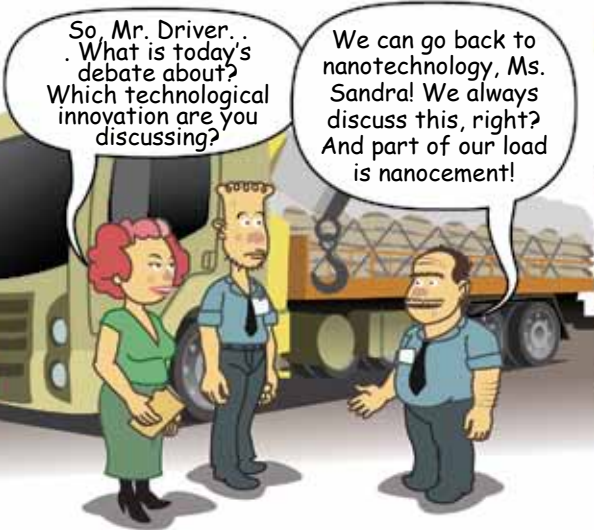
Okay, guys! The truck  
is already loaded! Time  
is up!

There we go. . . At least I'll  
learn what this so-called  
nanocement is.

As usual, she doesn't let  
us stay a minute longer!  
Humpf!

bulletin board

CIPA MEETING  
13/10 CO



So, Mr. Driver... What is today's debate about? Which technological innovation are you discussing?

We can go back to nanotechnology, Ms. Sandra! We always discuss this, right? And part of our load is nanocement!

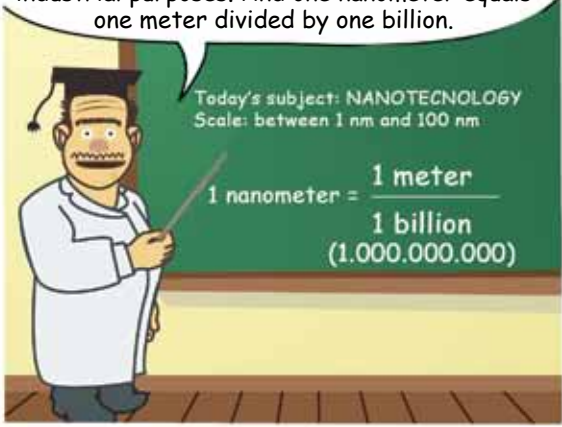


Before we start... I wouldn't be surprised if Gabriel started complaining that he doesn't understand anything, that he is confused...

I really don't understand it! Mr. Anthony, you can help me, can't you?

Okay, son... But it is the last time, huh? You have to get more updated about nanotechnology!

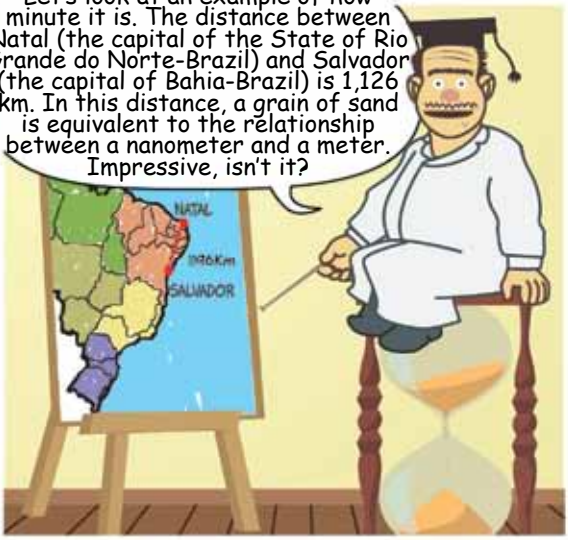
"Nanotech" is the study and manipulation of matter with at least one dimension sized from 1 to 100 nanometers for scientific and/or industrial purposes. And one nanometer equals one meter divided by one billion.



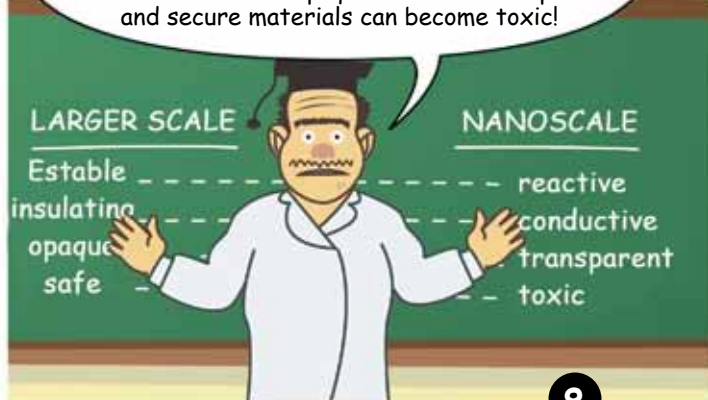
Today's subject: NANOTECHNOLOGY  
Scale: between 1 nm and 100 nm

$$1 \text{ nanometer} = \frac{1 \text{ meter}}{1 \text{ billion}} \\ (1,000,000,000)$$

Let's look at an example of how minute it is. The distance between Natal (the capital of the State of Rio Grande do Norte-Brazil) and Salvador (the capital of Bahia-Brazil) is 1,126 km. In this distance, a grain of sand is equivalent to the relationship between a nanometer and a meter. Impressive, isn't it?



At the nano level, the properties of materials can change. Thus, what is stable at a higher reactive size can become reactive at the nanoscale. Insulating materials can become conductive. What is opaque becomes transparent and secure materials can become toxic!



LARGER SCALE

NANOSCALE

Estable	-----	reactive
insulating	-----	conductive
opaque	-----	transparent
safe	-----	toxic

We need to draw close attention to this unpredictability of materials at the nano scale. How to determine accurately whether a certain element is safe, at the nanoscale? Shouldn't we find out more about the risks of nanoparticles and nanomaterials to human health?





Because of that, there are several concerns about the industrial applications of nanotechnology.

Nano goods are being made available to consumers even though we have no information about their risks to health.

Also, those people manufacturing these products may be at risk if studies on nanotech danger are not carried out.

Not to mention the risks to the environment and the danger of contamination.



Is my health at risk?

It's always the same thing: Gabriel asks what nanotech is and you are so pessimistic!

And the worst part is that the writer always places me between them both.

Come on, Ms. Sandra... The boy needs to have a critical view of new technologies!

But you need to bow down to the great possibilities offered by nanotech! Like this wonderful nanocement we are carrying!

Nanocement? This one I've never heard of!

Listen, according to the Union course on new technologies...



Ms. Sandra: I also read a lot about it and know what nanocement is! You can leave this explanation to me, Mr. Driver!

Look, guys, cement is a thin and gray powder, that, when in touch with water, it forms a mass. As it dries, this mass becomes a hard and tough material. That's why it's used in buildings!



Cement

water

mass

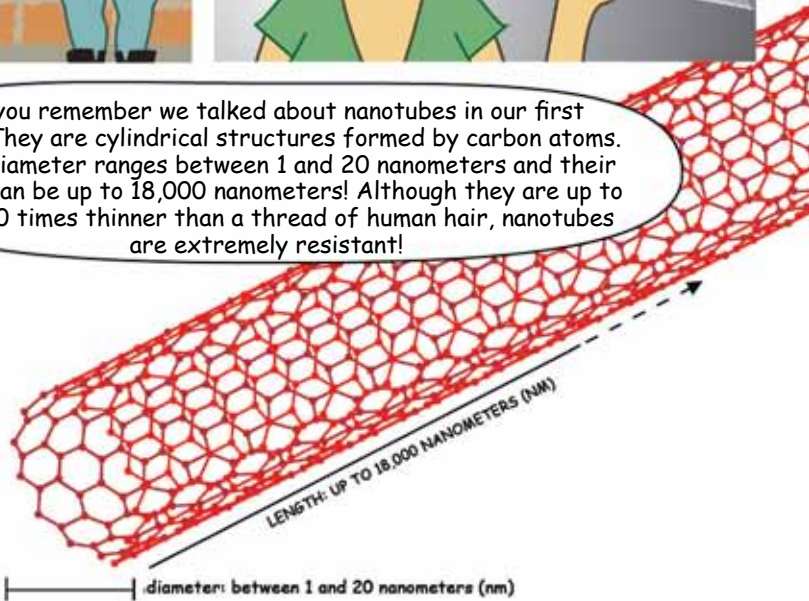


after drying, stiff and resistant material

Cement is the main element used in the Construction Industry. It is a ceramic material and limestone is the main raw material used in its manufacture. In its composition, there may also be small amounts of clay and iron ore.

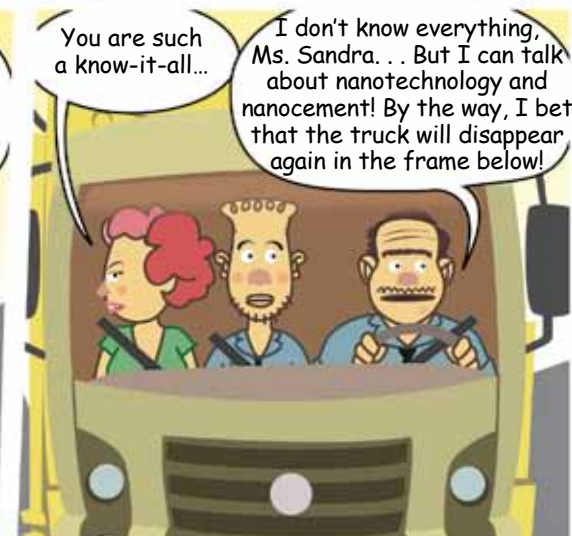


Do you remember we talked about nanotubes in our first issue? They are cylindrical structures formed by carbon atoms. Their diameter ranges between 1 and 20 nanometers and their length can be up to 18,000 nanometers! Although they are up to 100,000 times thinner than a thread of human hair, nanotubes are extremely resistant!



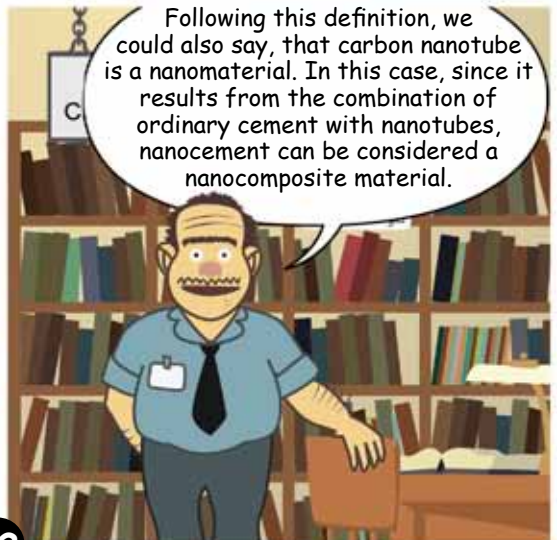
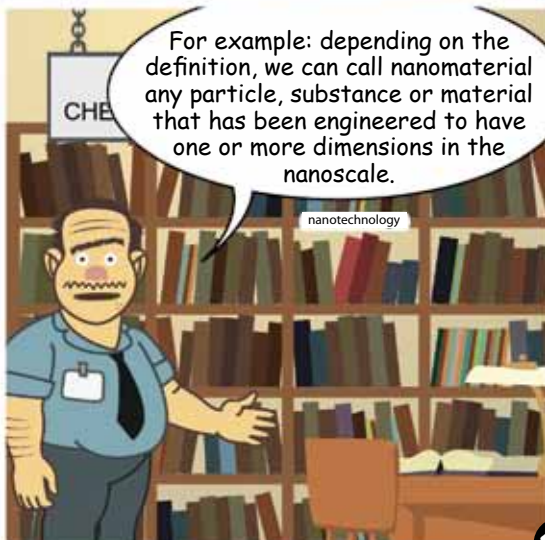
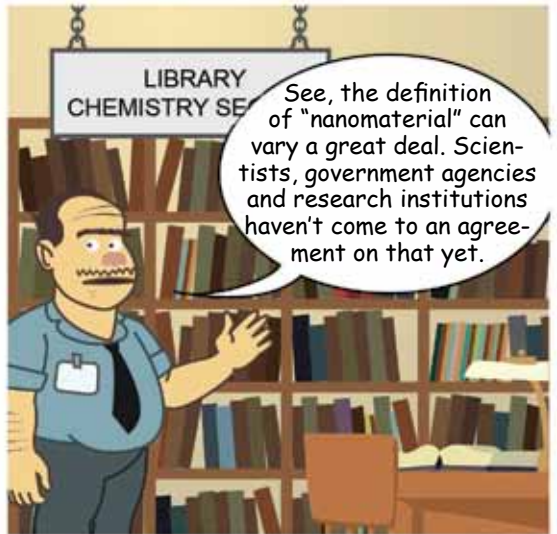
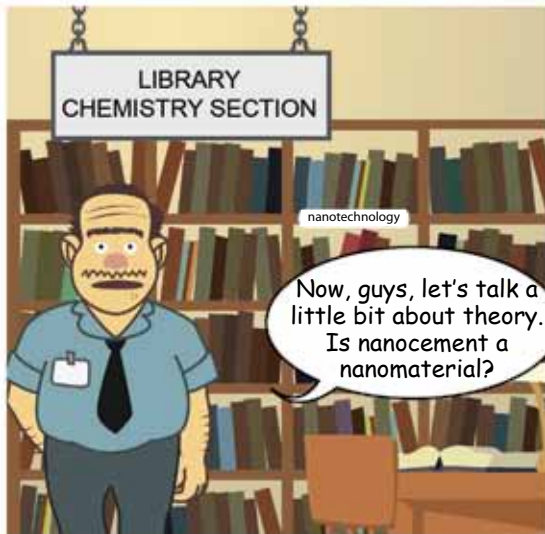
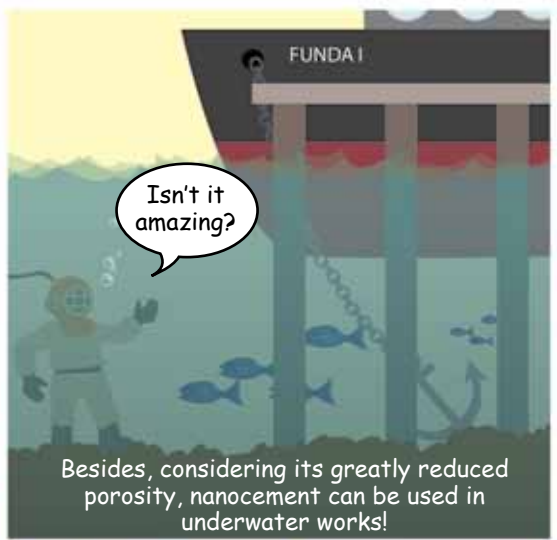
Nanotubes are object of studies for medical use, conductive and semiconductive materials, computer chips and many new materials just like the nanocement in this story! This cement is much tougher due to nanotubes in its composition, which makes it rather advantageous as construction material!

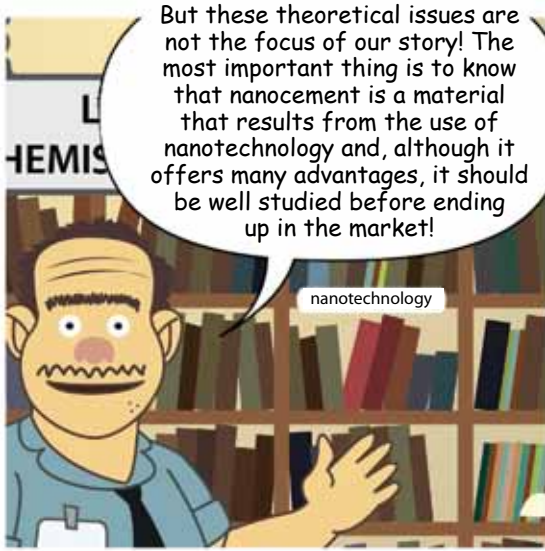




Nanocement has many advantages compared to ordinary cement, as you can see here in this ad!

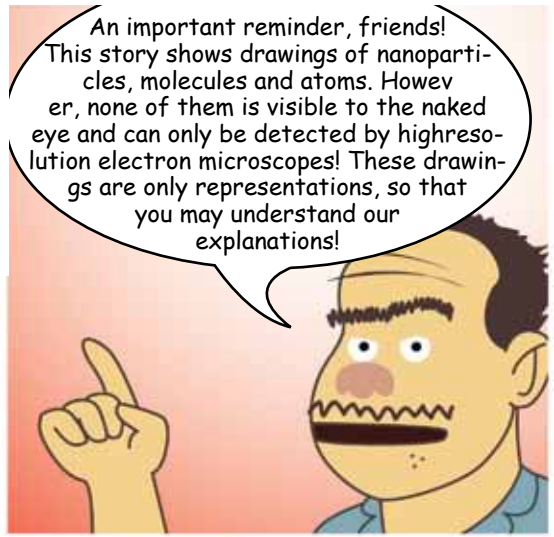
- Less porous!
- Resistance up to 3 times higher than the ordinary materials!
- Greater mechanical strength and bending resistance!





But these theoretical issues are not the focus of our story! The most important thing is to know that nanocement is a material that results from the use of nanotechnology and, although it offers many advantages, it should be well studied before ending up in the market!

nanotechnology



An important reminder, friends! This story shows drawings of nanoparticles, molecules and atoms. However, none of them is visible to the naked eye and can only be detected by high-resolution electron microscopes! These drawings are only representations, so that you may understand our explanations!



Beautiful explanation, Mr. Anthony... At least you were a little less pessimistic this time...

Well, Mr. Anthony! You just said that nanocement only has advantages!

Nanocement can revolutionize the construction industry. But I still think that caution is essential! For example, does nanocement offer any new risk to people's health?



Here comes the fear of new technologies again!

But he's right, Ms. Sandra! A new product needs to be tested before it hits the market!

And here's more: the workers who will handle these new materials need to be more alert! When we don't know the risks, we have to be cautious!



But what can workers do, Mr. Anthony?

They can turn to their Union, look for the Internal Commission for Accident Prevention of the company they work for, contact the governmental supervision bodies. They have many options!



Look! We've just arrived to the site where we have to deliver. Let's leave the Unionist talk for later!

Here we are... Hardly did we have time to listen to some folk music.

Some time later, at the construction site...

Ms. Sandra: Guys, as we did in our last delivery, we're going on a tour at our customers' workplace! These are Ernest and Vladimir! They work for the Spike Homebuilder!

Hello everyone, I'm Ernesto! I'm the foreman who coordinates the work on this site!

And I'm Vladimir! I work as a safety technician and I'll accompany you on your visit! Feel free to ask if you have questions!

Wow, what a big building! It doesn't even fit into the page!

Hello, friends!

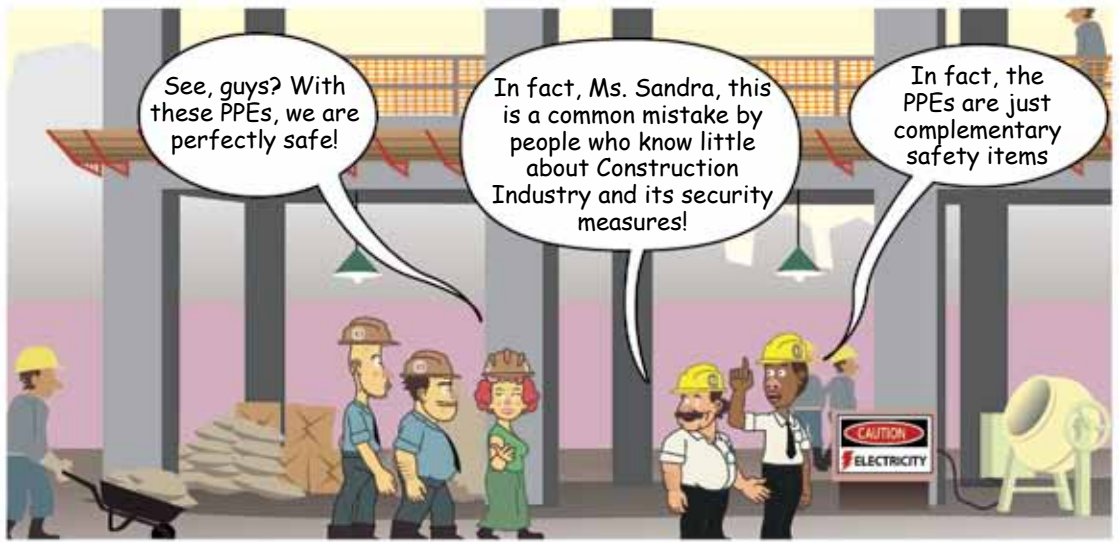
I'm Sandra, the delivery supervisor of New Universe Carrier! This is Anthony, our driver! And that is Gabriel, who works as Delivery Assistant!

So let's start our visit! I see you're all wearing hard hats, earmuffs and boots!

These three items are "personal protective equipment", also known as PPE!

Hard hats help to protect the workers against possible injury from falling materials or impacts! The rubber boots are important if they have to go through flooded areas! And the earmuffs attenuate the noise, protecting them from hearing loss.

Oops!



See, guys? With these PPEs, we are perfectly safe!

In fact, Ms. Sandra, this is a common mistake by people who know little about Construction Industry and its security measures!

In fact, the PPEs are just complementary safety items



The collective protection equipment, CPE, is even more important than the PPE!



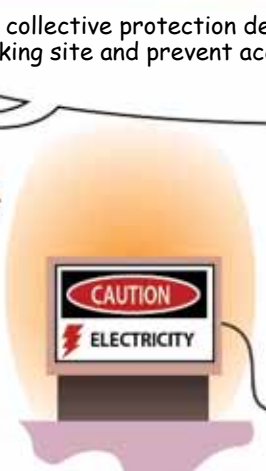
Wow! How interesting! And what are the differences between PPEs and CPEs, guys?

I know the answer to that question. . . But I'll leave it to our new friends!

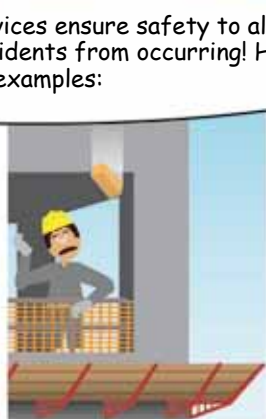
Humpf! CPE, PPE. . . Even I get confused with this bunch of acronyms!



Sills and guard rails where there is risk of falls.



Protection against electric shock.



Protective trays to prevent accidents caused by falling materials.



Well-built suspended scaffolds, with steel cables in good condition and well fixed.

As its name suggests, the personal protective equipment protects each worker individually! PPEs provide protection when there is risk of injury during the execution of the work or prevent the worker from getting hurt when an accident occurs!



hard hat



safety glasses



for situations in which the worker is exposed to high noise levels



various types of gloves



welder mask

Homebuilders are required to provide all protective equipment necessary for the safety of workers in their workplaces!



After a long walk and a lot of sightseeing...



See... As a foreman and member of the Internal Commissions for Accident Prevention here at the Spike Homebuilder, I think the issue of safety in the workplace is very important!

And I think the same applies to me, since I'm a safety technician!

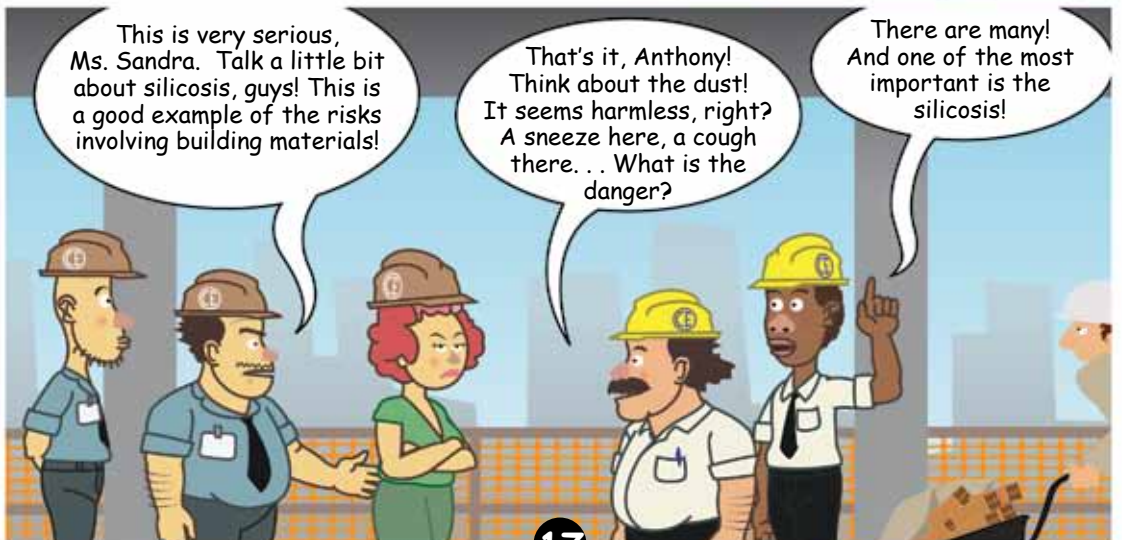


Besides, we got interested in two more things!

First, the load of nanocement you brought! We're always concerned with the new materials, their characteristics and their handling by workers!





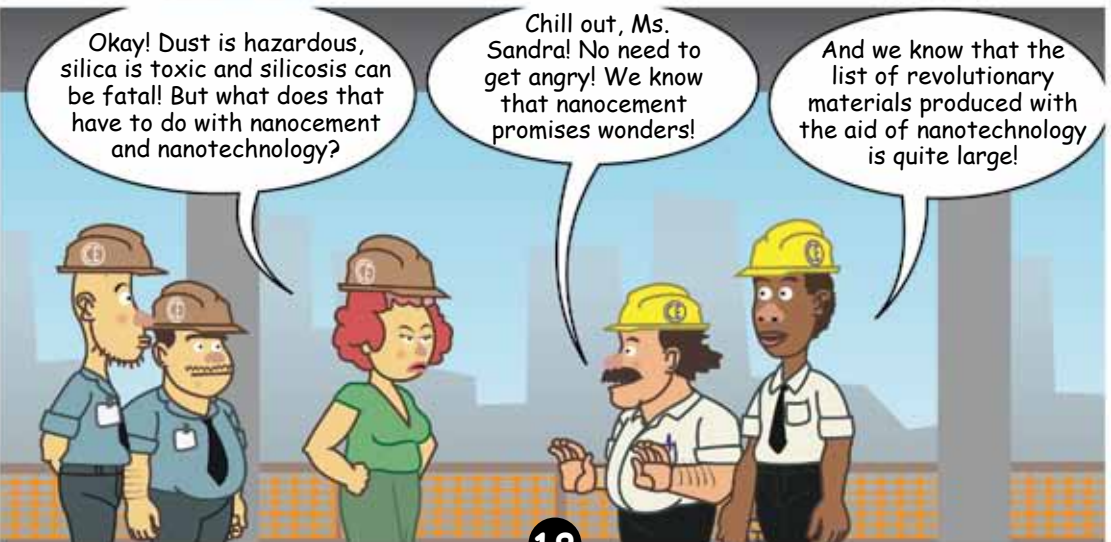


Silicosis is a disease caused by silica and is characterized by inflammation and scarring in the form of nodular lesions in the lungs. In practice, this impairs the organ and breathing gets harder and harder. It is a chronic disease with no cure.

In its most common variant, silica is a natural compound present in quartz! Silica is present in many materials used in construction, such as sand, gravel and granite!



- Whenever possible, silica must be removed or replaced!
- Dry cutting processes must be replaced by wet ones.
- Local exhaust ventilation and physical barriers between workers and sources of dust must also be used!
- When collective protection is not possible, companies must provide respiratory protection, such as the semifacial respirator with a mechanical filter!



It is possible to manufacture pipes and fittings from PVC nanocomposites! There are also frames with nanoceramic coating. . . And nanopaintings: dark paints that keep the cold walls and white paints that are able to absorb heat!



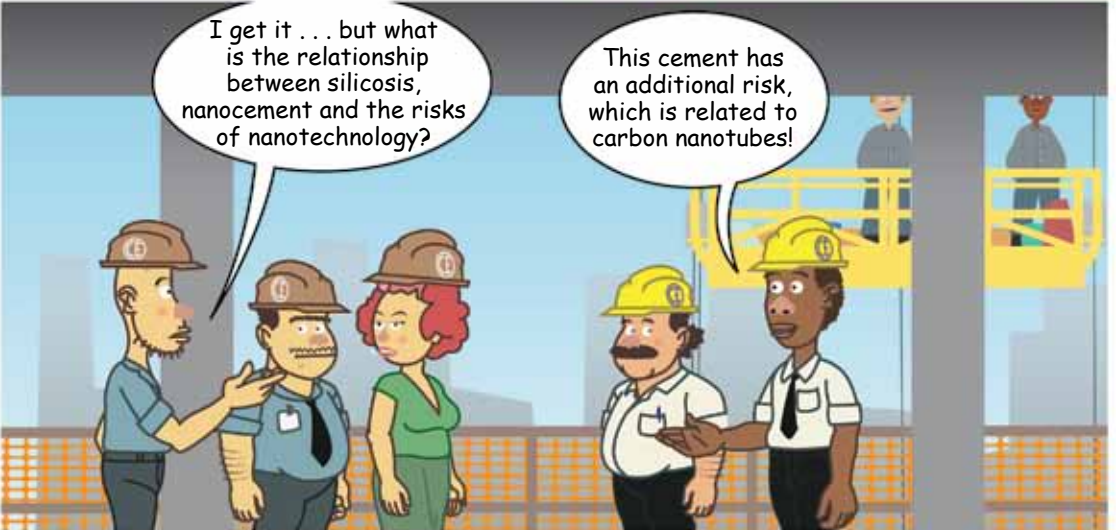
But even with many potential advantages, these new materials have a fundamental problem, which is common to all products involving nanotechnology. . .

he need for more studies on their possible impacts on the health and safety of workers and people in general!



I get it . . . but what is the relationship between silicosis, nanocement and the risks of nanotechnology?

This cement has an additional risk, which is related to carbon nanotubes!



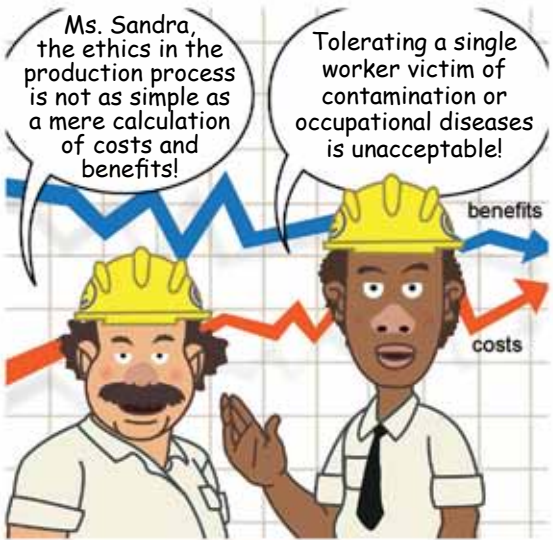
There are some studies showing that some carbon nanotubes may be carcinogenic. These studies indicate that some types of nanotubes can cause breathing problems and lung cancer if inhaled!



That's it! It also reinforces the need for labeling nanoworked products already available in the market!

Humph! I bet the advantages of nanocement outweigh any possible risk!





Ms. Sandra, the ethics in the production process is not as simple as a mere calculation of costs and benefits!

Tolerating a single worker victim of contamination or occupational diseases is unacceptable!

We can not compromise people's lives because of indiscretions in the production process. Ethics is related to precaution and to studies of the risks and impacts on the health and safety of workers and people in general. We've already had too many bad examples. . .



Let's see the guys lunch. . .

Cool! I'm Starving!

What a cool room for lunch, Ernest!

Yeah, Anthony. . . A room like this in the Construction Industry is rare! Construction workers still have a lot to fight for. . .

I hate minced meat. . .

Enjoy your meal, Ms. Sandra!



Well... But it is important to have a cool room for meals and rest. . .

Yeah, man. . .

With workers well organized, we'll get there!

See that building, man? I Helped to raise. It was a time of distress, It was four rides. two to go, two to get back.

## REFERENCES

- ASSOCIAÇÃO BRASILEIRA DE CIMENTO PORTLAND. Básico sobre cimento: fabricação. Disponível via WWW no URL: [www.abcp.org.br/conteudo/basico-sobre-cimento/fabricacao/fabricacao](http://www.abcp.org.br/conteudo/basico-sobre-cimento/fabricacao/fabricacao). Capturado em 15/02/2011.
- GARCIA, João Antonio; PINTO, Alexandre Custódio & VIEIRA FILHO, Antonio Gracias. Nanotecnologia: o transporte para um novo universo. São Paulo, Fundacentro, 2008.
- JENSEN, Thomaz Ferreira & VIEIRA FILHO, Antonio Gracias. Nanotecnologias: maravilhas e incertezas no universo da química. São Paulo, Fundacentro, 2010.
- JOACHIM, Christian & PLÉVERT, Laurence. Nanociências: a revolução do invisível. Rio de Janeiro, Jorge Zahar Editor, 2009.
- LADEIRA, Luiz Orlando. "Eficiente, simples e barato (entrevista com Luiz Orlando Ladeira)". In: Boletim da UFMG, no 1622, Ano 34. Disponível via WWW no URL: [www.ufmg.br/boletim/bol1622/5.shtml](http://www.ufmg.br/boletim/bol1622/5.shtml).
- SCHULZ, Peter. A encruzilhada da nanotecnologia: inovação, tecnologia e riscos. Rio de Janeiro, Vieira & Lent, 2009.
- TOMA, Henrique E. O mundo nanométrico: a dimensão do novo século. São Paulo, Oficina de Textos, 2004.
- ZARBIN, Aldo J. G. "Química de (nano)materiais". In: Química Nova, vol. 30, no 6, pp. 1469-1479. São Paulo, Sociedade Brasileira de Química, 2007.

This comic book was born out of the Project "Impacts of nanotechnology upon the health of workers and the environment", which began in 2007 at Fundacentro. This project is coordinated by Arline Sydneia Abel Arcuri and is developed in partnership with Renanosoma (Research Network in Nanotechnology, Society and Environment), IIEP (Exchange, Information, Studies and Research), Diesat (Inter-Union Department of Studies and Research on Health and Work Environments), Dieese (Inter-Union Department of Statistics and Socioeconomic Studies), Osasco Steelworkers Union, ABC Chemical Workers Union, the Social Observatory Institute, ENSP/Fiocruz (National School of Public Health/Oswaldo Cruz Foundation), SRTE/SP (Regional Superintendency of Labour and Employment - São Paulo/Brazil) and it has Leila Nadim Zidan as collaborator.

This text was developed by Antonio Gracias Vieira Filho, who prepared the motif and the script from discussions and proposals of the Project "Impacts of nanotechnology upon the health of workers and the environment" team.

The following technicians contributed to the comics:

Luis Renato Balbão Andrade; Mey Rose de Mello Pereira Rink; Maria de Fátima Torres Faria Viegas; Maria Gricia de Lourdes Grossi; Valéria Ramos Soares Pinto, José Tarcisio P. Buschinelli and Arline Sydneia Abel Arcuri, from FUNDACENTRO;

Ana Yara Paulino and Thomaz Ferreira Jensen, from DIEESE;

Daniele Correia, Eduardo Bonfim da Silva, Gilberto Almazani, Máira Andrade, Pérsio Dutra and Wilson Cesar Ribeiro Campo, from DIESAT;

William Waissmann, from Fiocruz/Cesteh;

Sebastião Lopes Neto from IIEP;  
Paulo Roberto Martins from Renanosoma;  
Mário Simões Mendes Júnior, from SRTE/SP;  
Leila Nadim Zidan, as collaborator.

The motif also had the collaboration of the editorial board of Fundacentro and the following colleagues of the Engineering Program of Safety in Construction Industry (Proesic), developed by Fundacentro: Francisco de Almeida Gusmão; Jose Helio Lopes Batista and Maria Christina Felix.

The initial idea to use a transportation company for all comic books was developed by Alexandre Custodio Pinto and the characters of the carrier were created by João Antonio Garcia, the Jão Garcia.

Other texts on the subject can be found at:

<http://nano.fundacentro.gov.br/>

<http://nano.iiep.org.br/node/>

<http://iiep.org.br/blog/nanotecnologia/>

<http://nanotecnologiadoavesso.org/>

[http://www.nanosaude.fiocruz.br/new /index.php](http://www.nanosaude.fiocruz.br/new/index.php)

<http://jusnano.blogspot.com.br/>

Short glossary (dictionary of terms) of nanotechnology can be found at:

[http://nano.iiep.org.br/sites/default/files/Glossario\\_nano.pdf](http://nano.iiep.org.br/sites/default/files/Glossario_nano.pdf)

---

**About comics**

Komika composite body 7  
offset paper 120 g/m<sup>2</sup> (kernels book)  
and “supremo” card 250 g/m<sup>2</sup> (cover)  
format 16 x 23 cm

circulation: 1.000 copies

Fundacentro graphics  
2015

Circulation: 1.000 exemplares

---

**MINISTÉRIO**  
DO TRABALHO E EMPREGO



**FUNDACENTRO**  
FUNDAÇÃO JORGE DUPRAT FIGUEIREDO  
DE SEGURANÇA E MEDICINA DO TRABALHO

Rua Capote Valente, 710  
São Paulo - SP  
CEP 05409-002  
Tel.: 3066-6000

**[www.fundacentro.gov.br](http://www.fundacentro.gov.br)**