

# Nanotechnology Safety Fact Sheet

HS25-0004A (05-25)

**N**anotechnology is transforming industries by enabling the creation and use of materials at an incredibly small scale—between 1 and 100 nanometers, thousands of times smaller than the width of a human hair. These engineered nanomaterials (ENMs) can make products stronger, lighter, more durable, or more effective in ways that weren't possible before. However, as nanotechnology becomes more common in workplaces, it also brings new health and safety challenges for workers and employers.



## What is nanotechnology?

Nanotechnology involves manipulating materials at the atomic or molecular level to create structures with unique properties. Because of their tiny size, ENMs can behave differently than larger particles of the same substance. For example, they might be more chemically reactive, conduct electricity better, or have different strengths and colors. These properties are what make nanotechnology so valuable—and sometimes unpredictable.



## Industries using nanotechnology

Nanotechnology is now used across a wide range of industries, including:

- **Health care and pharmaceuticals:** Targeted drug delivery, advanced imaging, and diagnostic tools.
- **Electronics:** Smaller, faster, and more energy-efficient semiconductors and sensors.
- **Energy:** Improved solar panels, batteries, and fuel additives.
- **Manufacturing and materials:** Stronger, lighter composites for vehicles, sports equipment, and construction.
- **Chemicals and coatings:** Enhanced paints, catalysts, and heat-resistant surfaces.
- **Food and packaging:** Improved food safety, shelf life, and packaging materials.
- **Personal care:** Sunscreens, cosmetics, and textiles with special properties.<sup>1</sup>



## Workplace hazards of nanotechnology

While nanotechnology brings many benefits, it also introduces new risks for workers. The very properties that make ENMs useful—like their tiny size and high reactivity—can also make them hazardous:

- **Routes of exposure:** Workers may be exposed to ENMs through inhalation, skin contact, or ingestion. Inhalation is often the most concerning, as nanoparticles can reach deep into the lungs and may even enter the bloodstream.<sup>2</sup>
- **Health effects:** Animal studies and some early workplace investigations suggest that certain ENMs can cause lung damage, cancer, organ toxicity, or skin and eye irritation. Because ENMs are so new, not all health effects are fully understood, and risks can vary widely depending on the type of nanomaterial and how it is used.<sup>3</sup>
- **Process-related risks:** Tasks like handling dry powders, mixing liquids, cleaning up spills, or maintaining equipment can all increase exposure risk, especially if ENMs become airborne.<sup>4</sup>

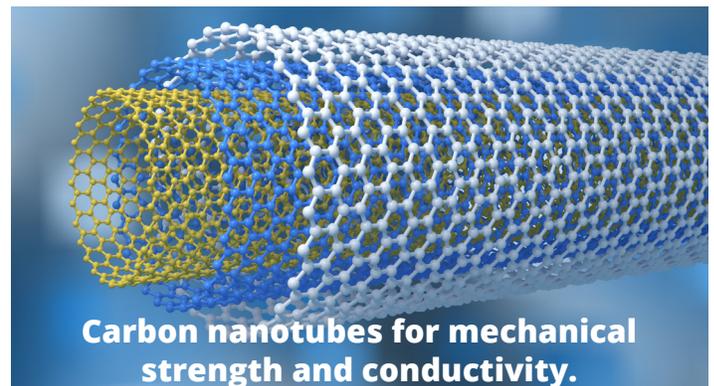
- **Unknowns:** There are still many unanswered questions about long-term effects, safe exposure levels, and how ENMs interact with other chemicals in the workplace.<sup>5</sup>

## Steps to keep workers safe

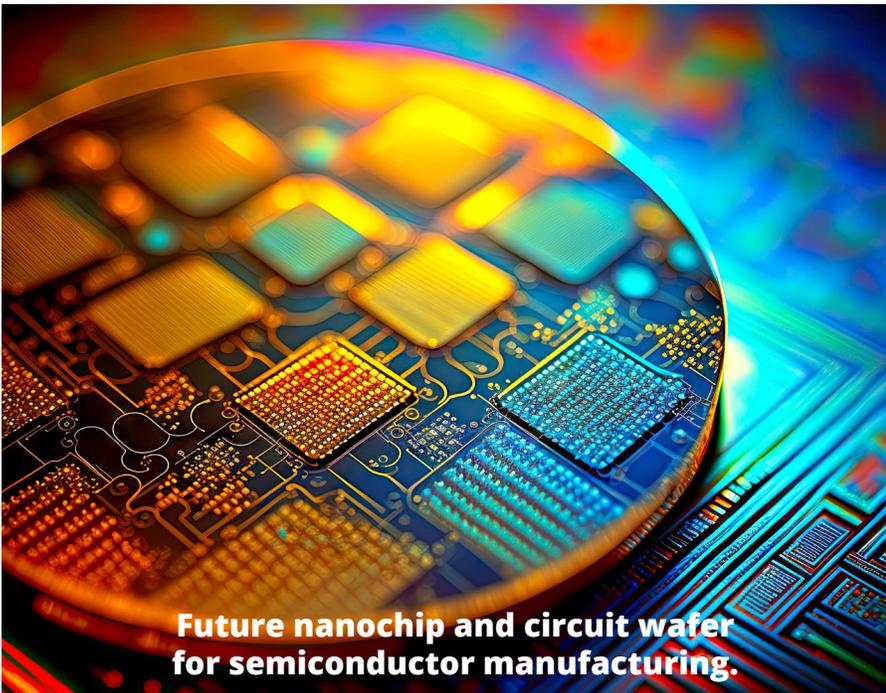
Because research is ongoing and regulations are still developing, employers and workers should use a precautionary approach. Here's how to reduce risks:

### 1. Identify nanomaterials in the workplace.

Understand which materials and products contain ENMs. Check with suppliers and manufacturers, and review [safety data sheets](#). Conduct a workplace assessment to identify tasks and processes that may release nanomaterials.<sup>6</sup>



**Carbon nanotubes for mechanical strength and conductivity.**



**Future nanochip and circuit wafer for semiconductor manufacturing.**

## 2. Assess exposure.

Use exposure assessment tools like the [NIOSH Nanomaterial Exposure Assessment Technique \(NEAT\)](#) to evaluate where and how workers might be exposed. Air and surface sampling can help detect the presence of ENMs, though methods are still evolving.<sup>7</sup>

## 3. Control exposures using the hierarchy of controls.

- ▶ **Elimination:** When possible, physically remove the hazard.
- ▶ **Substitution:** If possible, use safer materials or processes that do not involve ENMs.
- ▶ **Engineering controls:** Use ventilated enclosures (like glove boxes or fume hoods) with HEPA filtration to capture airborne nanoparticles. Local exhaust ventilation is critical when working with powders or during mixing and cleaning.<sup>8</sup>

## ▶ **Administrative controls:**

Develop safe work procedures, limit the number of workers exposed, and schedule high-risk tasks when fewer people are present.

▶ **Personal protective equipment (PPE):** Provide and require the use of appropriate PPE, such as NIOSH-approved respirators (N100, R100, or P100 filters), gloves (preferably nitrile, double-gloving as a best practice), lab coats, and eye protection. PPE should be properly fitted, maintained, and used consistently.<sup>9</sup>

## 4. Training and education.

Train all workers and supervisors on the hazards of ENMs, safe handling procedures, proper use of PPE, emergency response, and how to recognize signs of exposure. Ongoing education is essential as new information becomes available.<sup>10</sup>

## 5. Medical surveillance.

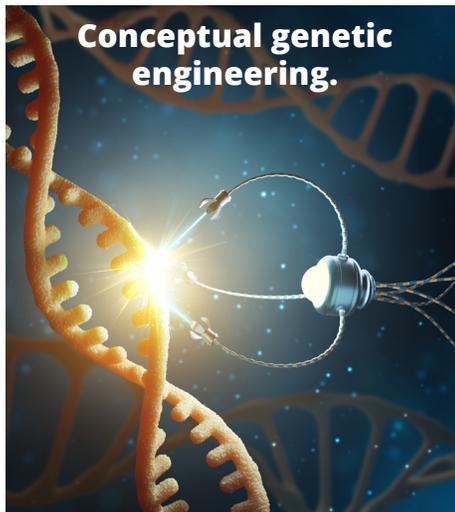
Offer medical screening and surveillance for workers who may be exposed to ENMs. This can help detect early signs of health effects and guide improvements in workplace controls.<sup>11</sup>

## 6. Monitor and review.

Regularly review and update risk assessments, control measures, and training programs. Monitor workplace exposure levels and stay informed about new research and regulations.<sup>12</sup>

## 7. Regulatory compliance.

Follow applicable OSHA standards (such as those for [respiratory protection](#) and [hazardous chemicals](#)), and keep up with evolving guidelines from NIOSH and other agencies.



Conceptual genetic engineering.

## The path forward

Nanotechnology is a rapidly growing field, offering exciting opportunities and new challenges for workplace safety. Because the science is still developing, employers and workers must stay proactive—identifying hazards, controlling exposures, and keeping up with the latest research and regulations. By working together and following best practices, it's possible to enjoy the benefits of nanotechnology while protecting the health and safety of everyone in the workplace.

For more information, consult resources from [NIOSH](#), [OSHA](#), and the [American Chemical Society](#), or reach out to the DWC Occupational Safety and Health Consultation ([OSHCON](#)) Program for guidance and assistance.

## References

- <sup>1</sup> National Nanotechnology Initiative, "Applications of Nanotechnology." Webpage. <https://www.nano.gov/about-nanotechnology/applications-nanotechnology>. Accessed May 27, 2025.
- <sup>2</sup> Occupational Safety and Health Administration, "OSHA Fact Sheet: Working Safely with Nanomaterials." PDF. [https://www.osha.gov/sites/default/files/publications/OSHA\\_FS-3634.pdf](https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf). Accessed May 27, 2025.
- <sup>3</sup> The National Institute for Occupational Safety and Health, "Continuing to Protect the Nanotechnology Workforce: NIOSH Nanotechnology Research Plan for 2018-2025." Webpage. <https://www.cdc.gov/niosh/docs/2019-116/default.html>. Accessed May 27, 2025.
- <sup>4</sup> National Institutes of Health, Office of Research Services, Division of Occupational Health and Safety, "Nanotechnology Safety and Health Program." PDF. <https://ors.od.nih.gov/sr/dohs/Documents/nanotechnology-safety-and-health-program.pdf>. Accessed May 27, 2025.
- <sup>5</sup> Journal of Physics: Conference Series, "Overview of Risk Management of Engineered Nanomaterials," by Schulte PA, Geraci CL, Hodson LL, Zumwalde RD, Kuempel ED, Murashov V, Martinez KF, Heidel DS. Article. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4556602/>. Accessed May 27, 2025.
- <sup>6</sup> Occupational Safety and Health Administration, "OSHA Fact Sheet: Working Safely with Nanomaterials." PDF. [https://www.osha.gov/sites/default/files/publications/OSHA\\_FS-3634.pdf](https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf). Accessed May 27, 2025.
- <sup>7</sup> Journal of Occupational and Environmental Hygiene, "Refinement of the Nanoparticle Emission Assessment Technique into the Nanomaterial Exposure Assessment Technique (NEAT 2.0)," by Eastlake AC, Beaucham C, Martinez KF, Dahm MM, Sparks C, Hodson LL, Geraci CL. Article. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4956539/>. Accessed May 27, 2025.
- <sup>8</sup> American Chemical Society, "Nanotechnology Safety Resources." Website. <https://www.acs.org/about/governance/committees/chemical-safety/publications-resources/nanotechnology-safety-resources.html>. Accessed May 27, 2025.
- <sup>9</sup> American Industrial Hygiene Association, "Personal Protective Equipment for Engineered Nanoparticles Fact Sheet." PDF. <https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/Personal-Protective-Equipment-for-Engineered-Nanoparticles-Fact-Sheet.pdf>. Accessed May 27, 2025.
- <sup>10</sup> National Institutes of Health, Office of Research Services, Division of Occupational Health and Safety, "Nanotechnology Safety and Health Program." PDF. <https://ors.od.nih.gov/sr/dohs/Documents/nanotechnology-safety-and-health-program.pdf>. Accessed May 27, 2025.
- <sup>11</sup> Occupational Safety and Health Administration, "OSHA Fact Sheet: Working Safely with Nanomaterials." PDF. [https://www.osha.gov/sites/default/files/publications/OSHA\\_FS-3634.pdf](https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf). Accessed May 27, 2025.
- <sup>12</sup> American Industrial Hygiene Association, "NIOSH Charts Nanotechnology Research Plan through 2025." Website. <https://www.aiha.org/news/niosh-charts-nanotechnology-research-plan-through-2025>. Accessed May 27, 2025.



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