

Nano Q&A

1. What does nano mean?

Nano means small and actually derives from the Greek word for a dwarf: nanos.

2. How is it defined in scientific parlance?

In its purest scientific sense, "nano" is 10^{-9} , or one billionth of something.

3. So, how big is a nanometer?

A nanometer is equal to one billionth of a meter. This is a staggeringly small measurement, but to give you some context, a nanometer measures about 80,000 times less than the diameter of the average human hair.

4. What is nanotechnology?

Nanotechnology is the term used to refer to the synthesis, control, engineering and manipulation of materials on the nanometer scale. By "nanometer scale", we mean at the level of several atoms and molecules.

5. What is the significance of nanotechnology in the world today?

Nanotechnology gives us the means to make reality a whole magnitude of opportunities that were previously unrealizable. We will be working with nature's fundamental building blocks and striving to develop a new generation of products that are faster, cleaner, stronger, lighter and more precise. Literally every knowledge-based economy has invested heavily in nanotechnology. Regionally, China, Japan, Taiwan and Korea are all investing in nanoscience and nanotechnology. The universal feeling is that nano has the potential to revolutionize the world.

6. How will we begin the process of developing applications?

Fundamental research is the key to getting the ball rolling. Nanotechnology is a truly multidisciplinary technology that unites researchers from a multitude of backgrounds. The development of applications will essentially cover all disciplines in pure science, especially physics, chemistry and biology, while the development of engineering applications requires the synergy of materials scientists, mechanical, chemical and electronic engineers, and medical researchers.

7. What types of application can be expected and what advantages will they bring?

The size advantage pertaining to nanotechnology obviously implies that smaller components can be used in the applications that we develop. In processors, for instance, signals can travel faster within smaller devices, so improved processing speeds can be achieved. More data can also be stored in a smaller volume.

- General applications:
- Energy storage products
- New types of flat panel display
- More powerful computers
- Ultra high capacity storage devices
- New medicines
- More potent catalysts
- Stronger materials

Nanotechnology will find its way into a broad spectrum of consumer markets, including:

- Cosmetics
- Textiles
- Nanoelectronics
- Photonics
- Optoelectronics
- Composite technology
- Environmental protection

8. What are nanomaterials?

Nanomaterials are any organic or inorganic materials that have building blocks, or particle sizes, between 1 and 100 nm. Nanomaterials possess physical and chemical properties that differ significantly from their bulky macroscopic counterparts, and these properties are essentially size-dependent.

9. How will these materials benefit us?

- **Creating new materials:** Through the control of the size of the nanomaterial constituents in the range of 1-100 nm and the manner in which these constituents are assembled, we will engineer and control the mechanical, thermal, electrical, optical and magnetic properties of the assembled nanostructures, leading to the discovery of a myriad of novel properties that will drive the development of new applications.
- **Impact on environmental sustainability:** Their durability and small size should mean a significant reduction in the amount of resources that we use, thereby diminishing the detrimental effect of waste on the environment, and reducing health concerns deriving from environmental degradation.
- **Economic benefits:** It is one of HKUST's goals to make nanomaterials more affordable. Take for example fullerenes (nano carbon balls). These are currently more expensive than gold. Nanomaterials research therefore has an essential role in supporting development of competitive and sustainable growth in Hong Kong and beyond.

10. Can you provide some examples of nanomaterials and their use?

Nanomaterials come in different forms and shapes. Examples are:

- **Nanofibers, such as nanotubes and nanowires:** In 2000, the University revealed its creation of the world's smallest single-walled carbon nanotubes. These nanotubes have unique physical structures and exciting electronic properties.
- **Nanoparticles, such as ultrafine particulates and fullerenes:** An HKUST team is currently developing an air-cleaning device that uses a TiO₂ nano-catalyst to remove poisonous matter from the air, for instance carbon monoxide and toluene.

納米問答

1. 納是什麼意思？

納(nano)的意思是細小，nano 這個字源於希臘文 nanos，意思是侏儒。

2. 科學上納的定義是什麼？

在科學上，納是一個表達微細數值的字首，代表 10^{-9} (十的負九次方)，或十億分之一。

3. 那麼，一納米有多長？

納米是表達微細長度的單位；一納米就是十億分之一米，大約等於頭髮直徑的八萬分之一。

4. 什麼是納米技術？

納米技術是對納米尺度的材料進行合成、控制、工程及處理等過程所需要的技術。所謂“納米尺度”，就是微細至材料內數個原子或分子單位的層次。

5. 納米技術對現今世界有什麼重要意義？

納米技術令很多以前無法想像的事物，都可望有機會一一實現。我們將可以運用大自然組成的基本單元，開發更快速、更環保、更強效、更輕便和更精密的新一代產品。目前，幾乎所有知識型經濟的國家和地區都已對納米技術進行大量投資，在我們的鄰近地區，中國、日本、台灣和韓國都在積極發展納米科學和納米技術，大家都一致認為，納米科技已擁有改革世界的潛力。

6. 在開發納米技術應用方面，我們可以從何入手？

基礎研究是推動納米科技發展的關鍵。納米技術是一門跨學科的技術，它把不同領域的科研人員聯繫起來：各個自然科學領域(尤其是物理學、化學和生物學)的研究人員為開發技術應用紮穩基礎；而材料科學家、機械工程師、化學工程師、電子工程師及醫學研究人員則從事工程應用的開發。

7. 納米技術有那些應用途徑，優點又在那裡？

納米技術的優勢是它從材料的微細層次著手，意味著我們可以在應用中，開發更細小的元件。以電腦處理器為例，由於元件越細，電子信號通過的時間便越短，從而提升處理器的運算速度；此外，更細的電路元件將可以儲存更多數據資料。

納米技術的一般應用包括：

- 能量儲存產品
- 新型平面顯示屏
- 功能更強的電腦
- 超高容量數據儲存裝置
- 新藥物
- 更有效的催化劑
- 更堅固的材料

納米技術在消費者市場上同樣具有廣闊的發展前景，包括：

- 化粧品
- 紡織品
- 納米電子
- 光子應用
- 光電子
- 複合材料技術
- 環境保護

8. 什麼是納米材料？

納米材料是由大小只有 1 至 100 納米的微粒組成的有機或無機材料；納米材料具備與宏觀世界中相同材料截然不同的物理和化學特性，而這些特性是與材料的大小息息相關。

9. 這些材料對我們有什麼益處？

- 創造新的材料：通過在 1 至 100 納米的層次上，控制材料內不同單元的大小及組合形態，我們將可以控制或改變材料的機械、熱、電子、光學及磁等特性，開拓無數具有全新特性的材料，推動新應用的開發。
- 環保及持續發展：納米材料的耐用性和微小體積，可以大大降低資源耗用量，從而減少廢物對環境的傷害，以及改善因環境污染帶來的健康問題。
- 經濟效益：科大的目標之一是降低納米材料的生產成本；以富勒烯（由碳原子組成的納米球狀碳分子）為例，現時它比黃金還要貴。因此，納米材料研究將為香港的競爭力和持續增長作出肯定貢獻。

10. 可否舉一些現有的納米材料例子，以及它們的用途？

納米材料有許多不同的形態，例如：

- 納米纖維：如納米碳管和納米線。2000 年，科大成功研製世界上最細小的單壁納米碳管，這些納米碳管展現獨特的物理和電子特性。
- 納米粒子：如超級精細的粒子和富勒烯。科大的一個研究小組正開發一種空氣淨化裝置，利用納米催化劑清除空氣中的有害物質，包括一氧化碳、甲苯，以及細菌和病毒。