Nanotechnology

State of the art nanomaterials production facility at the CSIR Nanotechnology Innovation Centre

Everything on Earth is made up of atoms - the food we eat, the clothes we wear, the buildings, the stationery we use at school and even our own bodies. The arrangement of atoms in something affects how strong or weak it is, if it has the ability to conduct electricity, if it is see-through, and even its texture. Atoms are extremely small to see with the naked eye or the typical microscope used at secondary schools' science classes and laboratories. They are a million times smaller than the thickest human hair. The diameter of an atom ranges from about 0.1 to 0.5 nanometres (1×10^{-10} m to 5×10^{-10} m). Nanoscientists and nanotechnologists can work with individual atoms and molecules to modify matter at a macroscale.

What is Nanotechnology?

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometres. The fields of nanotechnology and nanoscience involve the application of extremely small things and involve many differrent disciplines of science, including chemistry, biology, medicine, physics, materials science, and engineering. The field of nanotechnology and nanoscience has grown due to improved understanding of the characteristics of nanomaterials, the relationship between nanostructures and properties, and how these are engineered.

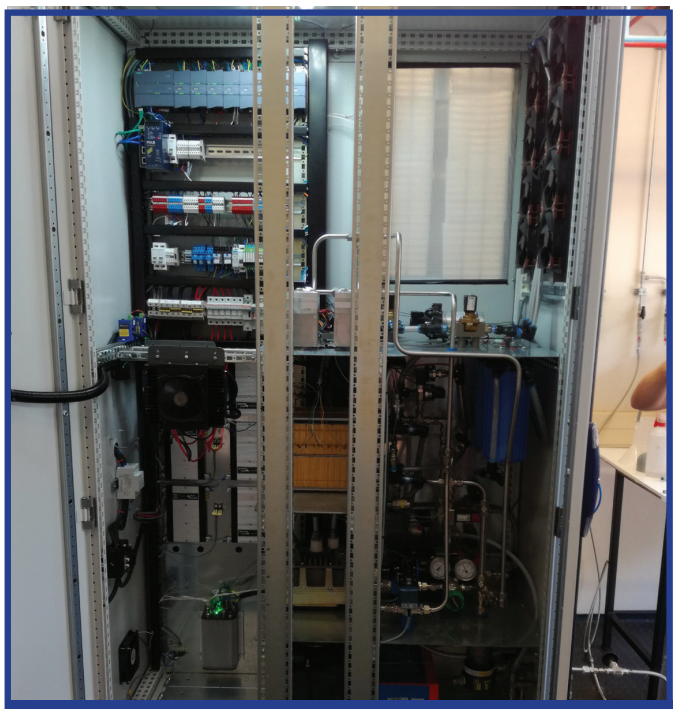
Applications of Nanotechnology

In South Africa nanotechnology has been applied in several industries, including energy conversion, aero-space and automotive, storage and distribution, nano-biotechnology, defence, chemical applications. The technology is continuously used to improve current products and processes, e.g. chemical processing done by SASOL and other local manufacturing industries.

Nanotechnology is also applied in various products such as the application of nanoparticles in paints, cosmetics we use on a daily basis, sunscreens and membranes used in water purification. With nanotechnology, new ways of synthesising or improving already existing products and processes are possible. The technology is having a great impact on several sectors including energy, medicine, electronics, ICT and other associated sectors.

Nanotechnology in Energy

In the energy sector, hydrogen energy is having impact as an alternative energy, and as an energy-carrier, due to the abundance of hydrogen and the relative prevalence of platinum, a key catalytic material in the fuel cell, in South Africa. The energy in hydrogen is electrochemically converted directly to electrical energy using fuel cell technology. This fuel cell technology is considered to be environmentally friendly, since the only waste produced from pure hydrogen is water.



Fuel cell system installation at Poelano Secondary High School in Ventersdorp providing off-grid electricity for ICT and lighting to the school.

Nanotechnology in Medicine

In medicine, nanotechnology has a future in advancing drug delivery. The third generation of nanotechnology could make an entirely new product such as sensors and devices that can monitor body functions, detect pathogens and environmental conditions, clothes that can clean themselves or regulate temperature. Scientists and engineers are using nanotechnology to improve humanity by finding various ways to improve materials at the nanoscale for use at a macroscale.

Dr Phuti Chelopo holds a PhD in Pharmaceutical Chemistry and specialises in nanomedicine for drug delivery

Dr Phuti Chelopo - Nanomedicine Researcher

1. What influenced you to pursue this career path and why did you choose it?

I always had a great interest in science, which was the stream of subjects I chose in Grade 10, and my favourite science subject was biology. This interest led me to pursue my 1st degree in biochemistry and chemistry. I then pursued both my MSc and PhD degrees in pharmaceutical chemistry. My PhD project involved the use of nanotechnology to improve the current treatment regime for tuberculosis. Before my PhD studies, I had developed an interest in the impact of nanotechnology to solve societal problems and having had the opportunity to be involved in it made me feel fulfilled. My greatest influence when choosing the career I did was to be involved in projects that have the potential to improve our everyday lives through science-based solutions, such as nanotechnology.

2. What average marks in matric (science and mathematics) are required to study a degree at a university?

I would recommend that students work hard to attain marks that are above 65% for their core science and mathematics subjects. Anything below 60% will risk one not being considered at the university.

3. What qualification does one need to pursue nanotechnology as a career, and what courses should one major in at a university?

Nanotechnology merges concepts from a variety of science disciplines, from concepts of chemistry and technology. At the university one can do a Bachelor of Science degree majoring either in biotechnology, chemistry, biochemistry or biology. Having two majors (co-majoring) is a possibility and will offer a greater advantage due to diversified skills. More importantly, continuing further to pursue MSc and PhD research will provide one with highly specialised skills in nanotechnology.

4. Where can one work with a nanotechnology degree?

One can work as a researcher at science councils or in academia (universities). One can also lecture at the university, while doing research and contributing to the knowledge base. Another contribution one can make as a nanotechnologist would be to work as a science expert at manufacturing companies that manufacture nanotechnology-based products. It is also very critical for the future upcoming scientist to start thinking of possible innovation they could pursue in their area of interest, such as nanotechnology for water purification or medical applications. This approach could help them become entrepreneurs who will contribute to economic growth.

5. What area of nanotechnology do you specialise in and what does it entail?

I focus on the use of nanomedicine for drug delivery purposes. Nanomedicine is the application of nanotechnology to make devices or systems for medical application at the scale of nanometre (1 to 100 nm). It involves the delivery of drugs, targeting and diagnostic agents using nanotechnology-based devices. My project involves the design of a drug delivery system for transporting anti-TB drugs more efficiently so that we can reduce the current treatment period of TB from six months to about two months.

6. What would you say is fulfilling about your career and which three words describe your occupation?

What fulfills me as a scientist is the desire to solve problems through science, which I can apply in a variety of areas. I am currently applying the skills I have obtained during my research in nanotechnology and nanomedicine to contribute to some of the activities that drive the 'Bio-economy Strategy" of the Department of Science and Innovation. The three words that describe my occupation is: Research; Innovation and Impact.

7. Take us through your job responsibilities briefly?

My day involves current research on innovations in the bio-science field and seeing how our economy can benefit or grow by correctly aligning itself. The activities ultimately lead to making an impact towards socio-economic developments.

8. What skills/talents does one need to excel in this field?

Dedication, willingness to learn, flexibility, communication and presentation skills, problem-solving and research and in-depth analytical skills.

9. What are the pros and cons of nanotechnology as a career?

The greatest advantage of this field is the enormous potential for growth. There are many great products that are yet to be discovered in this area with the potential to improve our everyday lives, such as improving health. Therefore with the right skills, there is great potential to grow in the field of nanotechnology. The cons of being involved in this field in our country are the low number of industries to offer employment. Therefore one has to work hard to pass tests and to prove your worth.

The Nanotechnology Public Engagement Programme (NPEP) is an initiative funded by DSI and implemented by the South African Agency for Science and Technology Advancement (SAASTA), a business unit of the National Research Foundation (NRF). NPEP aims to promote credible, fact-based understanding of nanotechnology through awareness, dialogue and education to enable informed decision-making on nanotechnology innovations to improve quality of life.

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