

Nanoscale physics underlie new telecommunications technology

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University of Wollongong physicists have discovered novel behaviours of materials that could enhance telecommunications technology.

From fibre optic cables delivering high-speed internet to [laser eye surgery](#), scientists' ability to manipulate [fundamental particles](#) of light (photons) is revolutionising our world.

New developments in [photonic devices](#) rely on fundamental physics and complex chemistry to extract the maximum efficiency and sensitivity to particles of light.

It's at the nanoscale that researchers from UOW's School of Physics have discovered a new method of constructing nanowires for use as semiconductors—the foundation of all modern electronics.

PhD student Julian Steele said the precision assembly of semiconductors at the nanoscale was undergoing an explosion of interest in scientific circles, due to their promise for building advanced electronic and photonic devices.

"Control over these tiny structures is important in determining their final applications," Julian said. "The more control we have over a wider range of materials, the more we extend the palette of functional design options available to engineers."

Silicon-based devices are currently the most widely used for telecommunications and circuit elements. Much further down the periodic table of elements is an exotic element called bismuth.

When added to the elements gallium and arsenide, the heavier bismuth resists entering the gallium-arsenide crystal and gathers on the surface in small droplets.

"These droplets act as a catalyst for the growth of nanostructures, which in this case turned out to self-assemble in the form of tracks," Julian explained. "The nanotracks themselves were grown by our collaborators at in the UK and the US, who were actually trying to grow solid thin-film materials.

"We were able to add to the work in understanding what we were seeing and why the tracks formed. The problem with trying to understand how the nanotrack shape is formed is the fact that only a handful of theoretical models exist to describe how they grow, and none that explains our unusual shapes."

"Our work also proposes a new type of growth model in detail. A simulation based on the model has fantastic agreement with our experiment and yields insights into the physical origins of some of the more exotic features observed in these nanotracks."

A critical feature of the work is the self-assembly process. In the right environment, the materials will aggregate and form structures without external interference or direction.

Self-assembly, when understood, can be applied to

simplify and speed up the construction of complex materials using nanowires, leading to advanced applications.

This could include new devices such as flat-panel displays thinner than currently available; high-efficiency solar cells that can be integrated onto surfaces such as the exterior of a car; and nanowire batteries that can hold up to 10 times the charge of existing lithium-ion batteries.

"Because of the price tag currently attached with their fabrication, the science of nanowires still remains in the world of laboratories," Julian said.

"In the same way that the development of [new materials](#) late in the 20th century helped to realise our current tech-age - from smartphones to driverless cars - the next frontier is how to assemble these [materials](#) at the nanoscale in order to exploit small-scale physics (quantum mechanics), for enhanced efficiency and function."

The research was published recently in the high-impact nanotechnology journal *Nanoscale*.

More information: J. A. Steele et al. Mechanism of periodic height variations along self-aligned VLS-grown planar nanostructures, *Nanoscale* (2015).
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