

New research explores the limits of nanomaterials and atomic effects for nanotechnology

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One-of-a-kind multi-probe LT Nanoprobe at Swansea University used to obtain the electrical measurements of nanowires that were correlated to atomic resolution imaging. Credit: Swansea University

Research by scientists at Swansea University has shown that improvements in nanowire structures will allow for the manufacture of more stable and durable nanotechnology for use in semiconductor devices in the future.

Dr Alex Lord and Professor Steve Wilks from the Centre for NanoHealth led the collaborative research published in *Nano Letters*. The research team defined the limits of electrical contact [technology](#) to nanowires at atomic scales with world-leading instrumentation and global collaborations that can be used to develop enhanced devices based on the nanomaterials. Well-defined, stable and predictable electrical

contacts are essential for any electrical circuit and electronic device because they control the flow of electricity that is fundamental to the operational capability.

Their experiments found for the first time, that atomic changes to the metal catalyst particle edge can entirely alter electrical conduction and most importantly reveal physical evidence of the effects of a long standing problem for electrical contacts known as barrier inhomogeneity. The study revealed the electrical and physical limits of the materials that will allow nanoengineers to select the properties of manufacturable nanowire devices.

Dr Lord, recently appointed as a Senior Sêr Cymru II Fellow part-funded by the European Regional Development Fund through the Welsh Government, said: "The experiments had a simple premise but were challenging to optimise and allow atomic-scale imaging of the interfaces. However, it was essential to this study and will allow many more materials to be investigated in a similar way.

"This research now gives us an understanding of these new effects and will allow engineers in the future to reliably produce electrical contacts to these nanomaterials which is essential for the materials to be used in the technologies of tomorrow.

"The new concepts shown here provide interesting possibilities for bridged nanowire devices such as transient electronics and reactive circuit breakers that respond to changes in electrical signals or environmental factors and provide instantaneous reactions to electrical overload."

The Swansea research team used specialist experimental equipment at the Centre for NanoHealth and collaborated with Professor Quentin Ramasse of the SuperSTEM Laboratory, Science and Facilities

Technology Council¹⁻³ and Dr Frances Ross of the IBM Thomas J. Watson Research Center, USA.³ The scientists were able to physically interact with the nanostructures and measure how atomic changes in the materials affected the electrical performance.

Dr. Frances Ross, IBM, USA, added: ""This research shows the importance of global collaboration, particularly in allowing unique instrumentation to be used to obtain fundamental results that allow nanoscience to deliver the next generation of technologies."

Nanotechnology is the scaling down of everyday materials by scientists to the size of nanometres (one million times smaller than a millimetre on a standard ruler) and is seen as the future of electronic devices. Progressions in scientific and engineering advances are resulting in new technologies such as computer components for smart devices and sensors to monitor our health and the surrounding environment.

Nanotechnology is having a major influence on the Internet of Things which connects everything from our homes to our cars into a web of communication. All of these new technologies require similar advances in electrical circuits and especially electrical contacts that allow the devices to work correctly with electricity.

More information: Alex M. Lord et al, Stability of Schottky and Ohmic Au Nanocatalysts to ZnO Nanowires, *Nano Letters* (2017). [DOI: 10.1021/acs.nanolett.7b02561](https://doi.org/10.1021/acs.nanolett.7b02561)

Provided by Swansea University

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