Australian Nanotechnology Alliance
Enabling Tomorrow

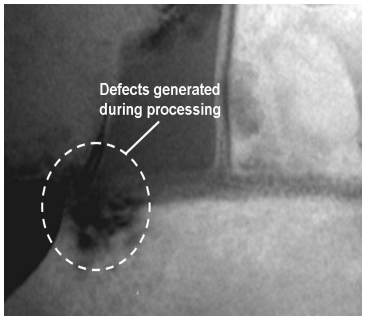
QUT

Solutions for Industry & the Environment Case Study:
Advanced multiscale modeling and simulation techniques in nanotechnology

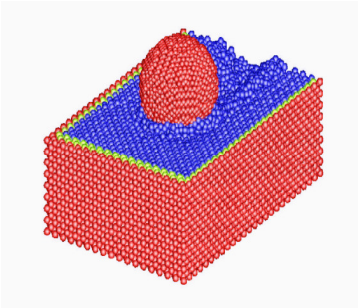
Researchers at QUT's Applied Nanotechnology group are developing advanced multiscale modelling techniques crossing macro/micro/nano dimensions for nano-manufacturing and nano-materials. The aim is to break through what has become an impasse by developing an innovative multiscale technique to allow reliable analysis across nanoscopic to macroscopic dimensions. The advance will enable precise exploration of the deformation mechanisms in complex systems of nano-manufacturing and nano-materials, so that quality and efficiency of these systems will be significantly improved through controlling and designing the whole processing not only the macro/micro-scale but also the nano-scale.

Background

Manufacturing has always been a major wealth-creating sector in developed economies and will be the cornerstone of long-term economic growth in Australia. Multiscale manufacturing and materials chjaracterisation have also produced new challenges. As a base for the multiscale technique, the behaviour and the properties of materials should be understood and exploited completely. To fulfil them, the existing experimental and simulation techniques are not applicable. It is urgent and critical in engineering to develop an advanced multiscale modelling technique crossing scales.



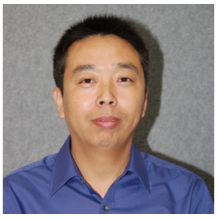
The nano-defects at the junction in an integrated circuit



Nano-machining

About the researcher Dr YuanTong Gu

Dr YuanTong Gu is a lecturer in the School of Engineering System at QUT (Brisbane). Before joining QUT, he



worked at the University of Sydney and University of California where he developed the advanced multiscale techniques for mechanical engineering.

Although he is still an early career academic, Dr. Gu is already one of the most important researchers in advanced numerical simulation for engineering. He has proposed a group of advanced meshless and multiscale techniques.

His current research is to develop advanced multiscale techniques crossing macro/micro/nano dimensions for manufacture and material engineering. He has been project leader and chief investigator in 2 ARC Discovery Projects on nano-manufacturing and nano-devices.

http://nanotechnology.org.au

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Research aims and results

A novel transition technique with a damping capacity in the transition zones between the nano/meso/macroscopic regions has been developed to ensure the fully seamless and accurate transmission of physical quantities. A modified plasticity theory based on the multiscale analysis results is proposed to explore the multiscale deformation mechanism of materials. The concurrent modelling and simulation multiscale technique based on the combination of the macroscopic method and the atomic method is then developed.

We are developing this advanced multiscale modelling and simulation technique as well as the powerful software package. We are also applying this new technique to many practical problems in nano-manufacturing and nano-materials including nano-machining, integrated circuits processing, carbon nano-tube reinforced nano-composites, and nanoelectromechanical system (NEMS) devices.

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