

Sustainable and resilient infrastructure materials – new perspective from emerging nanomaterials

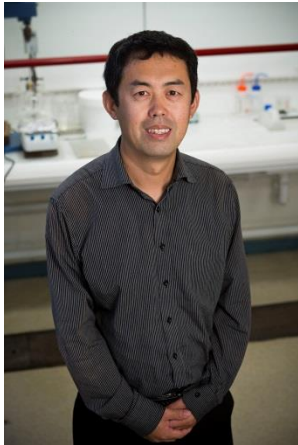
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Abstract

This presentation will provide an overview of the research activities within the Department of Civil Engineering at Monash University (Australia) on nano reinforced infrastructural materials. Since 2009, Dr Duan's group has investigated the effect of emerging nano particles extensively, including carbon nanotubes (CNTs) and graphene oxide (GO) sheets on enhancing the mechanical properties and durability of cement/polymer-based materials. Analytical, molecular dynamics simulations, and experimentation have been adopted in the research. In particular, a theoretical framework with supporting experiments will be discussed to address the effect of ultrasonication energy for carbon nanotube (CNT) reinforced OPC pastes. The distribution of CNT lengths and the concentration of dispersed CNTs are characterized using scanning electron microscopy images and UV-vis spectra. After ultrasonication, the length of CNT is found to follow log-normal distributions which show a shortening effect. The concentration of dispersed CNT increases with ultrasonication energy but reaches a plateau after about 250 J/ml. The distribution of CNT lengths and the concentration of dispersed CNTs are incorporated into a micromechanics-based model to simulate the crack bridging behavior of CNTs. In addition, the experimental results on graphene oxide (GO) reinforced OPC pastes will be presented as well with the comments on the advantages/disadvantages of GO for reinforcing purpose. Finally, the recent ARC Industrial Transformation Research Hub on nanoscience based construction materials manufacturing will be introduced. The hub will draw on the expertise of about 50 scientists and researchers from Monash and 30 partner institutions including CSIRO, Australian universities and industry, international research centres and universities including the National University of Singapore, Northwestern University (USA), and Princeton (USA). The research hub will develop novel construction materials including binders, cement additives, high performance concrete materials, concrete structural systems, polymer composites, and pavement materials.

Biography



Dr Duan graduated from Tianjin University (China) in engineering mechanics with B.Eng. and M.Eng. in 1997 and 2002, respectively. He received his Ph.D. from the Department of Civil Engineering, the National University of Singapore (NUS), Singapore in April 2006. Dr Duan joined the Department of Civil Engineering at Monash University as a Lecturer in November 2008 and was appointed as an ARC Future Fellow in February 2013. Dr Duan was promoted to an Associate Professor at Oct 2014.

Dr Duan conducted interdisciplinary research on nanocomposites and nanomechanics. By adding advanced nanomaterials such as carbon nanotubes and graphene oxide into conventional engineering materials such as epoxy, Portland cement, and geopolymer, Dr Duan has developed novel nanocomposites with high mechanical performances and reduced environmental impact. His research studies have resulted in more than 80 publications. Dr Duan's current h-index stands at 22 (Google Scholar). In the last six years, Dr Duan was awarded several ARC and industry grants on nanocomposites and nanomechanics totalling \$AUD 15 million including the most recent ARC IRTD Hub on nanoscience-based construction materials manufacturing.