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Xianfang Zhu

Xiamen University, China

Challenges to nanoscience and nanotechnology: Intriguing nanosize effect and nanotime effect

We first introduce a novel nanosize concept and a novel nanotime concept along with reviewing a series of novel phenomena and novel techniques related to nanosize effect and ultrafast process, which were recently discovered in our lab or were reported in literature. In these concepts, for the first time we are able account for the non-equilibrium, amorphous-like, and nonlinear nature of the current nanoscience and nanotechnology. In particular, we demonstrate that the structure instabilities of materials occur when a material system is limited to a space within a scale that is comparable to atomic distance. Such a nanosize effect is crucially dependent only on the nano-size but also on nanoshape or nanocurvature (including positive nanocurvature and negative nanocurvature). We also demonstrate that the structure instabilities of materials occur as well when the exchange of external energy with materials is limited to a time within a scale that is comparable to atomic vibration period. Such a nanotime effect can give rise to either soft mode or instability of atomic vibration in a condensed matter. The new concepts are very meaningful for control over fabrication and energetic beam processing of low dimensional nanostructures and nanodevices, especially for several potential applications related to nanoparticles, nanocavities, carbon nanotubem and nanowires. The new concepts have similarly important implications for chemistry, biology, and medicine as demonstrated by immerging new findings about nanocavities and nanolaser irradiation. In biology and medicine, there are widespread research interests either in using nanocavity (shell-core) structure to design and build biology composites, biosensors, drug deliverer and protein structures or in nanosurgery via ultrafast nanolaser processing, both being operative at the molecular level dealing with the concepts put forward herein.

Recent Publications

1. Zhu X F, Li LX, Su J B, Wang LZ (2015) Beam-induced non uniform shrinkage of single-walled carbon nanotube and passivation effect of metal nanoparticle. *J Phys Chem C*; 119: 6239-6245.

2. Zhu X F, Su J B, Wu Y, Wang L Z, Wang Z G (2014) Intriguing surface-extruded plastic flow of SiOx amorphous nanowire as a thermally induced by electron beam irradiation. *Nanoscale*; 6: 1499-1507.

Biography

Xianfang Zhu is one of the earliest scientists who initialized nanoresearch in China with over 30 years of research, teaching and industrial experience in a wide range of materials science and engineering areas. He has received PhD at the Australian National University followed up with a Postdoctoral experience at University of Illinois at Urbana, Champaign. He is presently the Director of the China-Australia Joint Laboratory for Functional Nanomaterials, an Adjunct Professor at The University of Queensland and a Full-Time Professor at Xiamen University, as well as the Chief Scientist for the AMAC International Inc., USA. Previously, he had also worked as a Senior Researcher in the Jefferson Lab and as an Assistant Professor at the University of Georgia. His current research interests are focused on nano-instabilities, nanoprocessing and nanofabrication. He has co-authored over 100 publications, filed 10 patents, chaired and co-chaired or served as Committee or Advisory Board Member at over 30 international and national conferences and presented over 70 invited lectures and talks at universities, research institutes and major international conferences worldwide and is Editor-in-Chief, Associate Editor of several international journals.

zhux@xmu.edu.cn