Innovative R&D and Computational Nanoscience Redefines Nanophase Materials

September 21 2004

Groundbreaking progress in nanotechnology is giving rise to heightened interest among investors, manufacturers, and other market participants. With progress comes new issues and challenges for theoretical scientists and, accordingly, increased demand for high-end research procedures and tools.

"Most of the research happening now is focused on improving upon existing materials properties or developing new materials," says Technical Insights Research Analyst Hrishikesh Bidwe. "These materials will initially find use in various high performance industries, such as aerospace and defense. If price can be significantly reduced, consumer applications will probably become the major market for nanophase materials."

Besides aerospace and defense, nanomaterials also will find increasing use in a variety of applications in various industries, including the automotive, healthcare, medicine, and electronics industries. The dimensional advantages offered by ultra-thin nanoscale films, for example, are optimal for their large-scale integration into micro- and nano-devices, and for device scaling.

In thin film applications, nanotechnology circumvents the disadvantages of having to perform thickness reduction in coatings and thin film materials. Further, the incorporation of nanophase materials has promoted thin film adhesion, providing significant performance advantages.

However, the economic fabrication of ultra-thin film coatings on a large scale poses a significant challenge. It requires precise and strict requirements and extremely clean conditions, since even the most miniature contaminant can adversely affect performance.

“New procedures are also necessary to measure and characterize the mechanical and electrical properties of ultra-thin films,” says Bidwe. “Nanoindentation tests have proven valuable, yet the scope for improvement and introduction of new methods remains vast.”

Nanotech-based quantum dots impart special optical and electrical properties to materials that are significant from fundamental and technological perspectives. Quantum dots are able to emit a wide range of wavelengths of light with changes in size. This property may allow the incorporation of quantum dots into applications such as tunable lasers and other optical components.

Still, much work must be done to reach viable applications. Since even a slight change in its properties can radically alter a quantum dot’s performance, the control of properties often creates difficulties in device applications. In grown quantum dot arrays, quantum dots frequently tend to clump, causing unwanted size variations. This offsets a quantum effect that is critical for optoelectronics.

Researchers have recently developed a technique that allows nanocrystals to self-assemble into sturdy and orderly arrangements, each insulated from the other by a layer of silicon dioxide. This method, which is both inexpensive and potentially commercially viable, prevents quantum dots from clumping.

Research in quantum dots has progressed from continuous improvement of synthesis and manipulation of individual quantum dots to creation of high-density quantum dot assemblies and preliminary fabrication of reallife optoelectronic and biomedical devices.

Other potential applications include the production of lasers, detectors, optical amplifiers, transistors, tunneling diodes, and other devices, and quantum dots may find use in forgery prevention and quantum computing.

“Pioneering developments in fundamental nanotechnology and innovative techniques such computational nanoscience are improving the ability to fabricate materials and incorporate them into devices,” says Bidwe. “With this, the emerging field of nanotechnology is moving out of laboratories toward real-world applications and commercialization.”

Source: Technical Insights

Citation: Innovative R&D and Computational Nanoscience Redefines Nanophase Materials (2004, September 21) retrieved 27 April 2024 from https://phys.org/news/2004-09-nanoscience-redefines-nanophase-materials_1.html