Precise semiconductor and carbon nanoshells and systems

V.Ya. Prinz

Institute of Semiconductor Physics SB RAS, Lavrent'ev Ave. 13, 630090 Novosibirsk, Russia

Nowadays the new approaches to high-precision fabrication of nanodevices are in urgent demand. In our previous works [1-3] we have invented a novel approach based on usage of molecular monolayers of solid-state crystal as initial building blocks for fabrication of various precise micro- and nanoshells (tubes, corrugations, scrolls, fibers, rings, helices, etc.). We have already shown that ultra-thin epitaxial heterofilms (down to two monolayers for InGaAs/GaAs) can be controllably detached from substrates and rolled or buckled in the form of micro- and nanoshells under the action of internal lattice mismatch strains [1]. The diameter of obtained tubes was up to 2 nm [1], nanocorrugated systems had period up to 10 nm [3]

It is shown that created three-dimensional nanoshells can be used as supporting or shape-generating constructions for precise spatial arrangement of clusters and fullerens. This technology is fully compatible with deposition of fullerens and atomic clusters on flat films.

For the first time the possibility of mass production of graphene nanoshells is demonstrated. The calculations of electronic structures of shells made of graphene and hybride films are presented.

The present review outlines the cornerstone stages of this fabrication technology for semiconductor and metal and hybrid nanoshells. A brief overview of the existing approaches to the formation of molecularly and atomically thin solid shells is given. Original data concerning the fabrication of functional two- and three-dimensional highly–ordered systems of interacting nanoobjects are reported. Also presented are first data on the formation of suspended graphene. A comparative analysis of electrical, mechanical, transport, and quantum properties of semiconductor [4, 5], hybrid, and graphene nanoshells is given. Based on this analysis, future trends in the application of such nanoshells are outlined.

[1] V.Ya. Prinz et al, *Physica E* **6**, 828 (2000).
[2] V.Ya. Prinz, *Physica E* **23**, 260 (2004); V.Ya. Prinz, *Phys. Stat. Sol. b* **243**, 3333 (2006); *Phys. E* **24**, 54 (2004).
[3] V.Ya. Prinz, V.A. Seleznev, *(in press)*.
[4] V.M. Osadchii and V.Ya. Prinz, *Phys. Rev. B* **72**, 033313 (2005).
[5] A.B.Vorob'ev, et al, *cond-mat/0703623v1* (2007), *Phys. Rev. B* (2007).