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Precise semiconductor nanotubes and nanocorrugated quantum systems: concept, fabrication and properties

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Physics and technology of several new classes of nanostructures, namely, variously shaped semiconductor, metal, dielectric and hybrid nanoshells, are overviewed. Previously, we discoved that ultrathin epitaxial heterofilms (down to two monolayers in thickness in the case of InGaAs/GaAs) can be controllably released from substrates and rolled up under the action of internal stresses into various cylindrical micro- and nanotubes, scrolls, rings, helices, etc. [1]. In this way, nanotubes with minimum diameter of 2-nm can be obtained. The fabricated nanoshells offer much promise as building blocks for nanoelectronic and nanomechanic devices, their fabrication technology being fully compatible with the well-established integrated-circuit technology [2]. Experimental and theoretical results concerning the quantum processes in the fabricated micro - and nanoshells are reported, including ballistic and tunnel transport in bent waveguides, magnetotransport, bending-induced formation of deep quantum wells and quantum dots molecules [3]. New results on the formation of spatially periodic nanostructures, nanocorrugated systems, shells with 1-nm minimum radius of curvature, building blocks for nanodevices and new nanocomposite materials are described. The present report outlines the cornerstone stages in the development of this fabrication technology for semiconductor and metal nanoobjects, including: directional rolling of films, super-critical drying of nanoshells, passivation of electron states in them, etc. Benefits offered by the new approach in the creation of 3D ordered nanoobject arrays, as well as challenges met in the development of the original nano- and molecular technology are discussed.

1. V.Ya. Prinz et al., Physica E 6, 828 (2000).
2. V.Ya. Prinz, Physica E 23 260; 24, 54 (2004).
3. V. M. Osadchii and V. Ya. Prinz, Phys. Rev. B 72, 033313 (2005).