Method for Fabricating Optical Semiconductor Nanotubes and Devices

Overview:
Semiconductor micro- and nanotubes allow incorporation of ordered structures such as quantum wells and quantum dots, thereby providing the potential for ultralow threshold micro and nano-scale lasers for use in applications such as ultrahigh-speed photonic systems as well as quantum information processing. The intellectual property provides processes of manufacturing these with high reproducibility, low processing complexity, and at high densities. Also provided is a means of releasing the micro- and nanotubes with low stress and a method of “pick-and-place” allowing micro- and nanotubes to be exploited in devices integrated on substrates that are either incompatible with the manufacturing technique or where the area of substrate required to manufacture them is not cost effective or performance of the circuit is compromised.

Figure 1: Illustrations of the formation of freestanding quantum dot microtubes on GaAs substrates. (a) & (b): The presence of a sinusoidal corrugation around the inside edge of the mesa leads to freestanding microtubes with an engineered geometry. (c) & (d) show the substrate-on-substrate transfer of freestanding microtube ring resonators from GaAs to Si substrates. The GaAs wafer is first placed directly on top of a Si substrate in the presence of solvent. Upon removing the GaAs wafer, the microtubes register on the Si substrate due to the gravitational force created by the solvent.

The Need:
Freestanding micro-tubes on Si can potentially overcome problems associated with the generation and propagation of dislocations in conventional III-V devices on Si due to the large difference in their lattice and thermal-expansion coefficients and surface incompatibility. Commonly used transfer techniques such as dry-printing and solution-casting can damage freestanding microtubes, which generally exhibit a large (10 μm) diameter but very thin (~100 nm) wall. To date, such microtube ring resonators on Si have not been demonstrated. The present technology provides a simple and controllable substrate-on-substrate transfer process, enabling the achievement of freestanding InGaAs/GaAs quantum dot microtube ring resonators on Si with properties identical to those on GaAs.

Figure 2: SEM image of a quantum dot microtube on Si. The sinusoidal geometry of the micro-tube surface is identifiable.
Inventor: Mi, Zetian; US 12/983,921

Profile:

Dr. Zetian Mi

Assistant Professor; Department of Electrical and Computer Engineering; McGill University William Dawson Scholar and Hydro-Quebec Nano-Engineering Scholar

Ph.D. University of Michigan (Applied Physics); 2006
PDF Electrical and Computer Engineering at the University of Michigan (2006-2007)

Research focus:

- Epitaxial growth and fundamental properties of semiconductor nanostructures, including quantum dots, nanowires, and nanotubes
- III-nitride materials and devices
- Light emitting diodes, lasers, solar cells, and solar hydrogen
- Quantum dot micro and nanotube photonics and Si photonics
- DNA sensors
- Nanowire transistors

CONTACT:

Derrick Wong
Office of Sponsored Research
McGill University
Tel: 514-398-5858
Email: derrick.wong@mcgill.ca
Reference code: 10055
Opportunity: exclusive license or research collaboration