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**Design of Semiconductor Nanowires for Electronics, Sensors and Energy Harvesting**

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In this presentation, I would summarize and discuss the recent progress in our research group, emphasizing the development of various nanostructured materials for different technological application. In the past decade, due to intriguing physical properties, one-dimensional (1D) semiconductor nanowires (NWs), especially III-Sb materials, have attracted attention as fundamental building blocks for next-generation electronics, optoelectronics, photovoltaics and so on. Although various device structures based on GaSb nanowires have been realized, further performance enhancement suffers from uncontrolled radial growth during the nanowire synthesis, resulting in non-uniform and tapered nanowires with diameters larger than few tens of nanometres. Here we report the use of sulfur surfactant in chemical vapour deposition to achieve very thin and uniform GaSb nanowires with diameters down to 20 nm. In contrast to surfactant effects typically employed in the liquid phase and thin-film technologies, the sulfur atoms contribute to form stable S-Sb bonds on the as-grown nanowire surface, effectively stabilizing sidewalls and minimizing unintentional radial nanowire growth. When configured into transistors, these devices exhibit impressive electrical properties with the peak hole mobility of ~200 cm2V-1s-1, better than any mobility value reported for a GaSb nanowire device to date. These factors indicate the effectiveness of this surfactant-assisted growth for high-performance small-diameter GaSb nanowires.

Apart from nanowire materials, we also demonstrate a facile but reliable photolithographic technique, which allows the rapid fabrication of highly ordered nanostructure arrays by employing soft transparent polymer films as optical masks for the area-selective exposure of a photoresist upon flood UV illumination. The soft polymer film either contains a monolayer of self-assembled (SAM) colloidal spheres inside at the near surface or has one side replicated from a SAM colloidal layer, in which the confined colloidal spheres or the surface textures can serves as lenses for light focusing. The geometrical feature of the patterns, including the size, pitch, and even the shape, can be finely tuned by adjusting the mask design, exposure time and the thickness of the photoresist layer. Instead of a single usage, the polymer mask can be used numerous times without noticeable distortions in the achieved patterns. The obtained patterns could be used as deposition or etching mask, allowing easy pattern transfer for various utilizations.

Reference:

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2. Yang Z., Han H., Fang M., Lin H., Cheung H.Y., Yip S.P., Wang E.R., Hung T.F., Wong C.Y., Ho J.C. "Surfactant-assisted Chemical Vapor Deposition of High-performance Small-diameter GaSb Nanowires", Nature Communications, 5, 5249, 2014.

3. Fang M., Lin H., Cheung H.Y., Yip S.P., Xiu F., Wong C.Y., Ho J.C. "Optical Nanoscale Patterning through Surface-Textured Polymer Films", Advanced Optical Materials, 2, 855-860, 2014. [Frontispiece Cover Article]