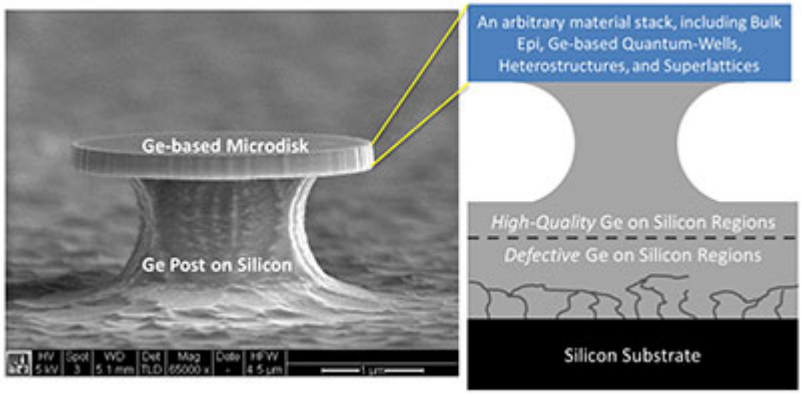
Docket #: S13-288

Method of creating improved material quality, suspended material structures on lattice-mismatched substrates for MEMS and photonics applications

Stanford researchers have improved material quality and suspension of micro- and nanostructures on lattice-mismatched substrates. Epitaxial growth of material on a lattice-mismatched substrate typically results in a large amount of defects due to misfit dislocations and threading dislocations that can greatly reduce performance. Typically, one can reduce the number of defects through continued growth and thermal annealing, forming a buffer layer upon which a desired structure of high material quality is grown. However, several applications require the removal of the defective regions of the buffer layer while protecting the desired structure, even if the buffer material and the structure are composed of the same or similar materials. This invention presents a method for removal of the defective buffer layer while creating a suspended structure by defining an etch-stop layer between the buffer layer and the desired structure. The process is entirely bottom-up growth with top-down fabrication requiring no wafer bonding or transfer process steps.



Applications

- Germanium-on-silicon based photonics
- Technology leveraging devices on relaxed, lattice-mismatched buffer layers
- Useful for MEMS technology and micromachining, specifically with Group IV materials

Advantages

- Improve the performance of devices due to the improved material quality in the suspended structure
- The core technology can be used to leverage a variety of devices and structures
- Applicable to several material systems (not just germanium based) that require high material quality structures on a lattice mismatched substrate

Publications

- Coleen K. Shang, Vivian Wang, Robert Chen, Suyog Gupta, Yi-Chiau Huang, James J. Pao, Yijie Huo, Errol Sanchez, Yihwan Kim, Theodore I. Kamins and James S. Harris, Dry-wet digital etching of Ge1?xSnx, *Applied Physics Letters* Volume 108, Issue 6: February 2016
- Suyog Gupta, Robert Chen, Yi-Chiau Huang, Yihwan Kim, Errol Sanchez, James S. Harris, Krishna C. Saraswat, "Highly Selective Dry Etching of Germanium over Germanium–Tin ($Ge_{1-x}Sn_x$): A Novel Route for $Ge_{1-x}Sn_x$ Nanostructure Fabrication", *Nano Lett.* 13, 3787-3790 (2013)
- Robert Chen, Suyog Gupta, Yi-Chiau Huang, Yijie Huo, Charles W. Rudy, Errol Sanchez, Yihwan Kim, Theodore I. Kamins, Krishna C. Saraswat, James S. Harris, "Demonstration of a Ge/GeSn/Ge Quantum-Well Microdisk Resonator on Silicon: Enabling high-quality Ge(Sn) materials for micro and nanophotonics", *Nano Lett.*, December 3, 2013.

Patents

- Published Application: 20150102465

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