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Scientists fabricate hexagonal silicon, potentially leading to light-emitting semiconductors

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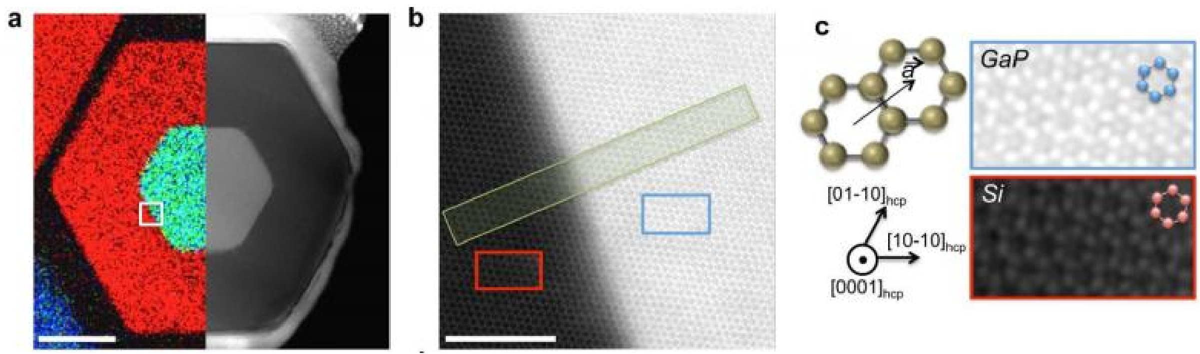

(a) One of the hexagonal nanowires on which the hexagonal silicon was grown. (b) Magnified image of the region marked with a white square in (a). (c) Magnified images of the regions marked with the blue and red boxes in (b), showing the hexagonal structures. Credit: Hauge, et al. ©2015 American Chemical Society

(Phys.org)—Virtually all semiconductors used in today's electronic devices are made of silicon having a cubic crystal structure, as silicon naturally crystallizes in the cubic form. In a new study, researchers have fabricated silicon in a hexagonal crystal structure, which is expected to exhibit novel optical, electrical, superconducting, and mechanical properties compared with cubic silicon.

The researchers, led by Erik P. A. M. Bakkers, a physics professor at Eindhoven University of Technology and Delft University of Technology, both in The Netherlands, have published a paper on their work in a recent issue of *Nano Letters*.

"Normal cubic silicon cannot emit any light because of its indirect band gap," Bakkers told *Phys.org*. "There are calculations that show that hexagonal silicon mixed with germanium should be able to emit light. Light emission in the electronics industry has been an important goal for more than 40 years. This would allow us to integrate optical communication directly on electronic chips. In the current work, we have shown that we can make pure hexagonal silicon. This is actually the first clear demonstration of this."

As the researchers explain, this is not the first time that hexagonal silicon has been reported; however, previous methods have had difficulty controlling the crystal formation and also lacked the ability to unambiguously verify the hexagonal structure.

In the new study, the researchers addressed both of these shortcomings by using new methods for fabrication and structural characterization. The new fabrication method involves depositing silicon on a template of hexagonal nanowires at high temperatures, resulting in high-quality hexagonal silicon. Due to the nanowires's vertical growth, there is no overlap to interfere with measurements that characterize the hexagonal structure, allowing unambiguous structural verification.

The researchers hope that the new method of fabricating high-quality hexagonal silicon will allow for a full assessment of the material's properties, and eventually lead to a way to synthesize a new class of semiconductors. In the near future, they plan to use the same method to fabricate hexagonal versions of germanium and silicon-germanium compounds, which could be particularly useful for the optical electronic applications Bakkers described above.

"The next step is to mix in germanium and study the optical properties," Bakkers said. "This seems to work, but is work in progress."

More information: Håkon Ikaros T. Hauge, et al. "Hexagonal Silicon Realized." *Nano Letters*. DOI: 10.1021/acs.nanolett.5b01939