Using chemistry for electronics and vice versa

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The microelectronics industry is continually striving to miniaturize conventional silicon-based electronic devices to provide higher performance technology that can be housed in smaller packaging.

Progress resulting from this miniaturization is evident from the rapid advances in consumer electronics, such as cell phones and laptop computers, that have been observed in recent years. Now, silicon-based molecular electronics -- a complementary technology to conventional microelectronics that could scale down electronic devices to the nanometer length scale -- may provide the next breakthrough in miniaturization.

"Molecular electronics offers the potential of utilizing individual organic molecules for electronic device applications," said Mark Hersam, assistant professor of materials science and engineering at the Northwestern University McCormick School of Engineering and Applied Science. "A single molecule device likely represents the ultimate scalability of electronic technology."

Hersam and graduate students Nathan Guisinger and Nathan Yoder recently reported their research advances in silicon-based molecular electronics as the cover article of the June 21, 2005 issue of the Proceedings of the National Academy of Sciences (www.pnas.org/cgi/content/short/102/25/8838).

In this work, a custom built cryogenic variable temperature ultra-high vacuum scanning tunneling microscope was utilized for imaging and probing individual organic molecules on silicon. At the cryogenic temperature of 80 Kelvin, the precision of these measurements surpassed previous efforts accomplished at room temperature. With this unprecedented data, the design constraints for silicon-based molecular electronic devices have been refined, Hersam said.

In an interesting twist, this study has also provided insight into the chemical and electronic structure of organic molecules mounted on silicon substrates. While the Northwestern study initially intended to use novel chemistry to improve electronics, the resulting molecular electronic device has also provided unique insight into the fundamentals of surface chemistry. In this manner, the work is likely to have impact in other fields, such as sensing, catalysis, and lubrication, where surface chemistry plays an active role. The research was supported by the National Science Foundation, Army Research Office and NASA.

Source: Northwestern University