An advance toward ultra-portable electronic devices

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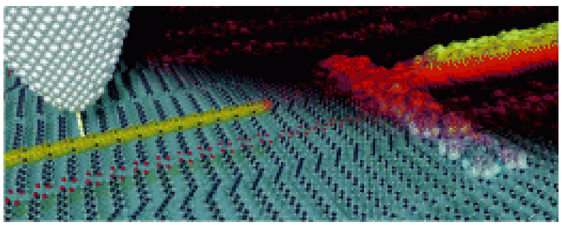

Scientists are reporting a key advance toward the long-awaited era of "single-molecule electronics," when common electronic circuits in computers, smart phones, audio players, and other devices may shrink to the size of a grain of sand. The breakthrough is a method for creating and attaching the tiny wires that will connect molecular components, reports a new study in the *Journal of the American Chemical Society*.

Yuji Okawa and colleagues write that the "key to single-molecule electronics is connecting functional molecules to each other using conductive nanowires. This involves two issues: how to create conductive nanowires at designated positions, and how to ensure chemical bonding between the nanowires and functional molecules." That challenge has stymied many researchers, who have struggled to produce wires small enough to use in molecular circuits.

The scientists now demonstrate a method that uses the tip of a scanning tunneling microscope to jump-start the formation of a molecule chain. The chain or "wire" spontaneously chemically bonds with other molecular components in the circuit under construction, a process that Okawa and colleagues dub "chemical soldering." The wiring method can be used to connect molecular switches, memory bits, and transistors. The scientists say their technique "will enable us to develop cheaper, higher-performance, and more ecological alternatives to conventional silicon-based devices."

More information: "Chemical Wiring and Soldering toward All-Molecule Electronic Circuitry", *J. Am. Chem. Soc.*, 2011, 133 (21), pp 8227–8233
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Abstract
Key to single-molecule electronics is connecting functional molecules to each other using conductive nanowires. This involves two issues: how to create conductive nanowires at designated positions, and how to ensure chemical bonding between the nanowires and functional molecules. Here, we present a novel method that solves both issues. Relevant functional molecules are placed on a self-assembled monolayer of diacetylene compound. A probe tip of a scanning tunneling microscope is then positioned on the molecular row of the diacetylene compound to which the functional molecule is adsorbed, and a conductive polydiacetylene nanowire is fabricated by initiating chain polymerization by stimulation with the tip. Since the front edge of chain polymerization necessarily has a reactive chemical species, the created polymer nanowire forms chemical bonding with an encountered molecular element. We name this spontaneous reaction "chemical soldering". First-principles theoretical calculations are used to investigate the structures and electronic properties of the connection. We demonstrate that two conductive polymer nanowires are connected to a single phthalocyanine

molecule. A resonant tunneling diode formed by this method is discussed.

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