On the way to plastic electronics: polymer-based DRAM

April 11 2006

Smaller, lighter, more compact devices that can do more and more, work faster, and juggle more data -- these demands are pushing conventional semiconductor technology up against its limits. In the future, plastics will have to take over. A number of polymeric electronic components have already been made. Researchers at the National University of Singapore and the Institute of Microelectronics in Singapore have now successfully produced DRAM storage based on a plastic.

The Singaporean team also recently made flash memory (a rewritable memory) and write-once read-many-times (WORM) memory based on polymers. Now they have introduced another type of memory, dynamic random access memory (DRAM), based on a polymer. In this “short-term” or “dynamic” memory, electronic devices temporarily store all processes -- storage units are updated by refreshing voltage pulses.

In contrast to a semiconductor chip, which “keeps track” of data in the form of electrical charge, the “0” and “1” signals in polymer-based memory are stored as high and low conductivity, respectively. The researchers produced a special copolymer, a plastic whose long molecular chains are made of two different components that are finely tuned to each other. This polymer is embedded as a thin film between two electrodes. The polymer is initially in the OFF state, which is characterized by low conductivity. A barrier hinders the flow of electrons through the film.

In order to “write” to the memory, a low voltage above a certain

threshold (-2.8 V) is enough to switch the copolymer into a highly conducting state, the ON state. The memory is “read” by means of voltage pulses below the threshold. The secret behind this device is the combination of the barrier and a kind of “pit trap” for charge carriers. If the barrier is first overcome above the threshold, the pits are filled with charge carriers. The altered electrical field then causes the barrier to become ineffective. The current can then flow through the film unhindered.

The pits are “shallow”, which allows the charge carriers to come out easily: If no voltage is applied for over two minutes they “climb” out of the pits on their own and the memory “forgets” its programming and returns to the OFF state. This is just what it should do as “dynamic” memory. “Erasing” the memory is accomplished by an opposing voltage pulse above +3.5 V. This immediately returns the memory to the original OFF state with empty traps. Renewed application of more than -2.8 V always returns the memory to its writeable state.

Citation: En-Tang Kang, A Dynamic Random Access Memory (DRAM) Based on a Conjugated Copolymer Containing Electron-Donor and -Acceptor Moieties, *Angewandte Chemie International Edition* 2006, 45, No. 18, 2947–2951, doi: 10.1002/anie.200504365

Source: Angewandte Chemie