

Polymer transistors show their soft side

In its present incarnation, the world of electronics has a hard edge. Made mostly from rigid parts, today's devices — radios, televisions, telephones, and so on — rely on components made mainly of metal, silicon, and ceramic to perform their tasks.

What if electronics could shed that hard edge? What if soft polymers and organic materials could offer sufficient electronic control to spawn a new generation of lightweight, flexible machines that could bend to human needs in ways that current products cannot?

Pursuing this vision, Francis Garnier, a materials scientist at the Laboratoire des Matériaux Moléculaires in Thiais, France, and his colleagues tell of their efforts to make flexible plastic electronic circuits.

Reporting in the Sept. 16 *SCIENCE*, they describe a method for making field-effect transistors entirely from organic polymers, using what they call "printing techniques."

"These are very simple, low-energy manufacturing methods compared to what people usually use to make amorphous, silicon-based devices," Garnier says. "Think of printing large circuits continuously on a roller, like a magazine."

Ordinarily, producing a computer chip requires powerful vacuums and high temperatures to deposit metallic materials on a silicon substrate. Such processes are cumbersome, energy-draining, and prone to error. Impurities often cause manufacturers to reject large numbers of chips. The new printing technique bypasses many of these difficulties, Garnier says.

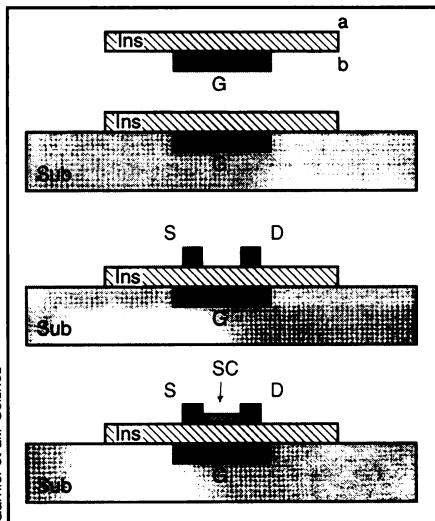
Though researchers have managed to make electrically conductive polymers in the past, both as electroluminescent diodes and as other forms of transistors (SN: 3/30/91, p.207; 10/16/93, p.246), they have been unable until now to rid the devices completely of metal attachments.

"This has been a problem," says Garnier, "because the polymers are flexible. So when they bend, the rigid connections tend to break."

The new method does away with metallic electrodes entirely, the group reports. As a result, the transistors not only show reliable electrical characteristics, such as low resistance and high current output, but also "are insensitive to mechanical treatments such as bending and twisting."

In a series of tests, the scientists rolled, twisted, and bent the devices as much as 90°. Yet they kept on working. By contrast, other rigid devices, including various organic transistors with metallic connections, stopped functioning when bent that much.

From such organic polymer electronics, Garnier envisions "pocket-sized 'smart' cards with plastic logic circuits." He also sees "car and airplane windshields that



Building a polymer transistor: Sandwich a gate electrode (G) between an insulator (top) and a substrate (bottom). Then deposit an organic semiconductor (SC) on top between electrodes (S, D).

can display information," as well as "a large flat panel display, like a television, that you could roll up."

"Even 5 years ago, people in the field said that to make good transistors only from plastics was totally unrealistic," he adds. "Now here it is." — R. Lipkin

The terrible twos just got younger

A smile quickly crosses the face of almost anyone who sees 1- to 2-year-olds trying out their newfound walking skills or grinning at passersby from the safety of their strollers.

Children in this age group, however, appear to have a different effect on many of their mothers. A new, preliminary study of 233 mothers of children between the ages of 1 and 2 finds that 42 percent of the moms showed symptoms of depression. About half of that group probably ranks as clinically depressed, report Ardis L. Olson and Lisa A. DiBrigida of Dartmouth-Hitchcock Medical Center in Lebanon, N.H.

However, mothers were much less apt to feel depressed if they liked their role either as a stay-at-home or an employed mom, the team reports in the September *PEDIATRICS*.

The study participants included primarily white, married, middle-class women taking their children to a pediatrician's office for a routine checkup. Ninety-six of the mothers did not work outside the home, 79 had part-time jobs, and 58 worked full-time outside the home.

Forty-three participants — in roughly equal proportions in the three groups —

reported feeling dissatisfied with their employment role. However, almost 70 percent of mothers who were not content exhibited symptoms of depression, compared to 35 percent of the satisfied group, Olson and DiBrigida report.

Moreover, they argue, results of the study suggest that "dissatisfaction with one's current work role does not simply reflect the malaise of depression."

Participants with part-time jobs had the lowest depression scores of the whole group, says Olson. On average, these women worked 20 hours a week. However, women dissatisfied with working part-time had the highest depression scores.

Part-time employment "needs to be considered as an option that may enhance mothers' mental health," Olson and DiBrigida assert.

The study's findings on part-time work confirm that having a variety of roles that boost self-esteem helps inoculate women against depression, says Ellen McGrath, a psychologist in Laguna Beach, Calif.

Other researchers have reported lower rates of maternal depression than the Dartmouth team found. Health experts often consider depression a problem of economically disadvantaged mothers. But investigations are uncovering increasing rates of depression among young adult women of all income levels, Olson and DiBrigida report.

Olson believes that their study found such a high rate of depression because they interviewed only mothers of 1- to 2-year-olds, a particularly difficult age. "I tell mothers the 'terrible twos' are the 6 months before 2," Olson says.

"The constant vigilance needed to insure physical safety as well as the child's struggle for autonomy contribute to make the toddler year particularly stressful for parents," the investigators argue.

Their questionnaire also uncovered feelings that other studies had failed to reveal, Olson says. The depressed women felt overwhelmed, alone, and full of self-doubt. "Mothers just carry this around as baggage," says Olson. "They think, 'This is how I'm supposed to feel as a mother of a toddler.'"

Robin Post of the University of Colorado Health Sciences Center in Denver applauded the study for informing pediatricians that mothers of toddlers may easily feel depressed. However, the study has shortcomings, she says. For example, the researchers do not compare their group to mothers of older or younger children. Nor do their findings necessarily apply to women from other cultural or economic backgrounds.

The researchers are again interviewing the participants, whose children are now 4 to 5 years old. They expect to find happier moms. They are also investigating how marital satisfaction affects mothers' depression. — T. Adler