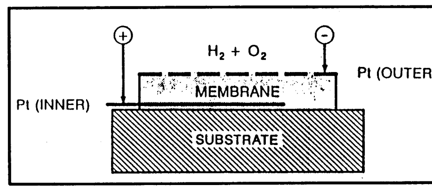
Microchip power from a shrunken fuel cell



Dyer/NATURE

Placing miniature power supplies right where they're needed on integrated-circuit chips is a quick and efficient way of getting electrical power to a circuit's microscopic components. This goal now seems within reach with the construction of a tiny, thin-film fuel cell that generates electricity when one of its electrodes is exposed to a mixture of air and hydrogen.

"It's probably the smallest electrochemical device that anyone has ever built," says Christopher K. Dyer of Bell Communications Research in Morristown, N.J. Such a device could have a broad range of applications, from low-cost, portable power supplies to information processing. Dyer describes his unconventional fuel cell in the Feb. 8 NATURE.

Just as a solar cell converts light energy directly into electrical energy, Dyer's fuel cell converts chemical energy, from the reaction between hydrogen and oxygen, directly into electrical energy. The device consists of a porous, aluminum-oxide membrane only 2,000 to 5,000 angstroms thick, sandwiched between two thin platinum films that serve as electrodes (see diagram).

When exposed to a mixture of air and hydrogen at room temperature, the device develops a potential difference of roughly 1 volt between its electrodes and generates a few milliwatts of power per square centimeter. "There's never been anything in electrochemistry quite this small that can give such a high voltage with mixed gases," Dyer says.

But why the device works remains a mystery. "It's not the sort of thing that you, as an electrochemist, would predict could happen," he says. Conventional fuel cells cannot operate with gas mixtures.

"Regardless of the precise mechanism involved," he adds, "the facility with which the phenomena can be reproduced with a variety of different membrane materials should lead to rapid duplication of these results."

The possibility of using relatively simple manufacturing techniques to fabricate these miniature, thin-film fuel cells at a low cost suggests a variety of applications. Dyer and his colleagues are investigating how to deposit these devices on integrated circuits, especially for supplying power to tightly packed, high-speed switches. They are also looking into the development of lightweight, portable power supplies fed by a stream of methanol vapor and air, which could be used instead of batteries.

One barrier to such applications is the fuel cell's low power output. But researchers may solve that problem by depositing the fuel cell's thin layers on a rough rather than a smooth surface, furnishing a greater surface area on which the necessary electrochemical reactions can occur.

The fuel cell also has a relatively low energy-conversion efficiency. "You wouldn't see this in a huge power-generating plant," Dyer says. "It's purely a convenience power supply, comparable to a small battery, where the cost of the fuel is not important." — *I. Peterson*

Releaf for greenhouse? Don't cut old forests

Can chopping down old forests help curb global warming? In recent years, some logging proponents have maintained the United States could help slow the atmospheric accumulation of carbon dioxide by replacing old-growth forests with faster-growing young trees. But a new study of young and old forests in the Pacific Northwest refutes that idea.

"The argument that we're somehow reducing the greenhouse effect is just totally fallacious. It is not an argument for cutting down old growth," says Mark E. Harmon of Oregon State University in Corvallis, who conducted the study with William K. Ferrell of Oregon State and Jerry F. Franklin of the University of Washington in Seattle.

The loggers' logic may seem reasonable at first glance, says Harmon. Younger trees grow much faster than older ones, so a hectare of young forest does pull more carbon dioxide out of the atmosphere each year than a hectare of old-growth forest. Meanwhile, timber gets harvested and incorporated into buildings, keeping dead wood from decomposing and releasing carbon dioxide into the atmosphere.

But this quick analysis disregards the facts that older forests store much more carbon than younger ones and that much of the harvested wood does not get stored in long-lasting structures.

To compare a 60-year-old hemlock forest with a 450-year-old Douglas fir/hemlock forest, Harmon and his colleagues reviewed the literature and added up all the carbon stored in living trees as well as in dead wood and organic debris on the forest floor. The young forest held less than half the carbon of the old-growth forest, they report in the Feb. 9 SCIENCE. Using a computer model, the researchers determined that it takes about 200 years for the storage capacity of a replanted forest to approach that of an old-growth forest.

In their analysis, the researchers also examined the fate of harvested wood from old-growth forests. They found that large portions are burned or turned into paper and wood chips that rapidly decompose and release carbon dioxide. Almost half the carbon in the cut trees may be lost into the atmosphere during a few years, says Harmon.

Paul Alaback of the U.S. Forest Service in Juneau, Alaska, has reached similar conclusions in studying old and young forests in Alaska and Chile. In both cases, he says, replacing old forests actually adds carbon dioxide to the atmosphere.

The new findings have not fallen on deaf ears. Last February, while testifying before a Senate subcommittee, Forest Service Associate Chief George M. Leonard agreed with a statement by Sen. Frank H. Murkowski (R-Alaska) that replacing old growth with younger trees "is part of an answer rather than part of the problem" with regard to the atmospheric buildup of carbon dioxide. Leonard now says Harmon's study has helped change the Forest Service's thinking on that issue. — *R. Monastersky*

Flowers for the dinosaurs

While angiosperms, or flowering plants, dominate the modern landscape, they were just getting their start during the early Cretaceous period when dinosaurs roamed the land. Botanists have long pictured the earliest angiosperms as large plants, something like magnolia trees, but a newly identified fossil and other evidence suggest a much tinier image.

In the Feb. 9 SCIENCE, David Winship Taylor and Leo J. Hickey of Yale University describe an Australian fossil that shows the earliest known angiosperm flowers, dating back about 110 million years. Lacking petals and measuring about 1 millimeter across, the minute reproductive organs connect to two small leaves, each about 1 centimeter wide. The tiny size of the plant supports other evidence depicting the first angiosperms as small herb-like plants rather than trees, Taylor says.

This revision in thinking may help explain some problems paleobotanists have faced. Scientists who study pollen remains know that angiosperms evolved several million years before the time of this Australian fossil, yet they have had trouble finding fossils of wood, leaves or flowers from these earliest forms. According to Taylor, researchers may have been looking with the wrong picture in mind. Indeed, he notes, those who first described the Australian fossil did not realize it was an angiosperm and instead identified it as a fern. □