Although the subcommittee found too many problems for its liking, the report notes that consumers were not overly dissatisfied. It attributed that to the pioneer spirit in many early solar buyers, but said that continued problems — in design, manufacturing and installation, "particularly in residences" — could end up retarding the fledgling industry.

In a New England experiment, 100 solar water heaters in one year of operation presented 165 problems, including malfunctions in: collectors (23); piping (60); valving (21); tanks, heat exchangers or electric heaters (7); pump or blower motors (20); controllers (33); and "miscellaneous" (1). The second year went better, with researchers estimating that average energy savings will reach 40 percent. The subcommittee notes, however, that improvement followed replacement or "major modifications" of 72 of the systems.

In a Florida survey, 46 percent of solar-system owners reported problems, the report notes. A Department of Energy project with 40 air- or water-heating installations reported similar results: With an undertone of Murphy's law, it said, "where possible," 29.5 percent of those systems experienced freezing, 37.7 percent a collector-to-manifold leak, 27.5 percent a controller malfunction and 55 percent a collector malfunction.

Seeing similar results in its own survey, the subcommittee calls for solar-product standards, expanded federal training of solar installers and inspectors, and Federal Trade Commission control of sales claims. Information on problems in the federal-demonstration program should be disseminated quickly to the solar industry and its customers, the subcommittee said. In addition, requirements to qualify for federal solar tax credits should include product warranties, and suppliers should provide customers with operating and maintenance instructions, the subcommittee report said.

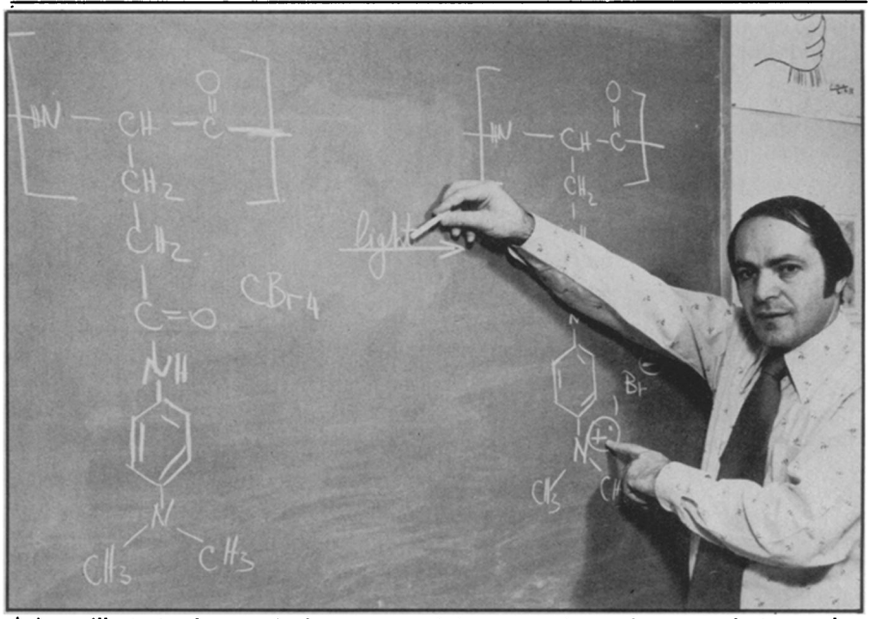
What's more, the subcommittee recommends that federal tax incentives be extended to passive systems. As they are now written, tax credits — 30 percent of an expenditure on a "renewable energy source" up to $2,000, and 20 percent of the rest up to $10,000 — can't be applied to structural work. And structure is central to the five passive systems that the subcommittee thinks are ready for "widespread use." They include:

- direct gain, or clustering of windows — preferably double-glazed, on a building's south side,
- a mass storage wall of the type popularized by Felix Trombe, which absorbs heat through a window and delivers it to a room through convection and radiation,
- a "sun-space," or greenhouse, which can be attached to an existing structure whose facing wall would serve the same purpose as Trombe's,
- storage of solar energy in containers in a roof for delivery by radiation through the ceiling in the evening (a "passive" system that must use movable insulation to prevent heat loss to the sky at the time of day it's collected), and
- the "indirect thermosyphon" in which heat-storage mass is placed above collectors to allow heat transfer without mechanical assistance.

While lack of information has confined much passive work to government labs and a few custom-designed houses, there are measures that consumers of active systems can take to protect themselves. The subcommittee report provides a sketchy guide and ample references for further reading. Appendices detail survey results, serving as guides to the most frequent malfunctions.

Another useful report is a rating of the potential for solar heating in different regions of the country, based on climate. That potential is given as multiples of the potential of the least promising region — around Lake Ontario. The report, authored by Walter Hoecker of the National Oceanic and Atmospheric Administration, permits consumers to gauge how a given solar system — whose performance at any U.S. location is known — will be likely to perform in their neighborhood. □

New material converts light to expansion



IBM

Aviram illustrates how a single segment of the new polymer loses an electron, when exposed to ultraviolet light, allowing more liquid to swell the sponge.

Irradiation with ultraviolet light makes the jelly-like substance slowly swell. In about four minutes, it expands 35 percent in each dimension. This light-sensitive polymer sponge stimulates expectations of a new technology for printing plates, photocopying and light intensity measurement.

Ari Aviram of IBM's Thomas J. Watson Research Center has synthesized the novel spongy material, which is formally named poly-*p*-(N,N-dimethylamino) -N-gamma-D-glutamanilide. He hooked together long chains of the amino acid glutamate and then crosslinked them with dimethylamino groups, making a porous structure.

The light-induced expansion results from interaction of the polymer and appropriate surrounding liquids. When the material is irradiated with ultraviolet light, Aviram has demonstrated that an electron moves from each dimethylamino group to the liquid (such as carbon tetrabromide). That ionization leaves the "holes" in the polymer sponge more receptive to liquid, and influx of that liquid causes the visible expansion. The total volume change observed is an increase of about 145 percent.

Although other chemists have occasionally observed polymers to change size during light irradiation, this synthesis is the first deliberate creation of a substance that swells dramatically with light.

Future research will attempt to reverse the swelling chemically or electrochemically, to develop materials that expand more quickly and to respond to various parts of the light spectrum. In his current work Aviram wants to understand more completely the new material and the mechanisms that cause it to undergo size transformation.

But Aviram is willing to speculate on applications, because past materials which undergo dimensional change, especially in surface relief, have proved useful in printing and information display: "A substance that swells upon irradiation might allow production of printing plates via a computer-controlled ultraviolet light source without the use of solid type." □