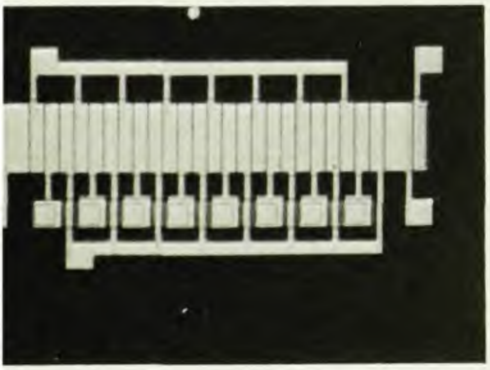
ond to the storage value. The process can then be repeated. Once the charge has been transferred to the desired location, it can be detected by putting it into an external circuit.

The minority carriers can come from three sources: from bulk or surface generation–recombination centers within the depletion region, from hole–electron pairs produced by incident radiation or from the first p-n junction.

Because the device transfers charge (information) from one place to another, it serves as a shift register. Although the first model holds eight bits, the experimenters hope to put strings of the registers together, each about 100 bits long; Smith says that as many such registers as desired (conceivably millions) could be tied together. After 100 bits are shifted, though, one has to regenerate the signal, because it is attenuated as the transfer occurs.



8-bit shift register. Device stores charge carriers in potential wells created at surface of semiconductor and moves them by moving potential minima.

The charge-coupled device can serve as an imaging device by allowing the light image to strike the substrate, creating electron–hole pairs. The holes will then diffuse to the electrode side where they can be stored in the potential wells created by the electrodes. When enough energy has been stored, the information can be read out using the shift-register technique.

Charge-coupled devices can be made with the same technology already used for integrated circuits. However, Smith told us, to make the device work the electrodes must be close enough—about 0.1 mil—to allow the occurrence of charge coupling from one electrode to the next. Present manufacturing tolerances between metallization are about 0.3 mil.

A shift register made with insulated gate field-effect transistors (IGFET) would occupy several times the space of a charge-coupled shift register. Although charge-coupled devices would be compact and easy to fabricate, these advantages may be offset (to a still uncertain extent) by complexities of generation, regeneration and sensing.—GBL

X-ray data suggest existence of 3-K blackbody radiation

More evidence that the cosmic three-degree blackbody radiation does not have a hump in its spectrum at about 1 mm has been reported by E. T. Byram, T. A. Chubb and Herbert Friedman of the Naval Research Laboratory [*Science* **169**, 366 (1970)]. Measurements by James Houck, Kandiah Shivanandan and Martin Harwit (and subsequently by Dirk Muehlner and Rainer Weiss) had indicated a flux 50 times higher than expected from a 3-K blackbody spectrum (PHYSICS TODAY, July 1970, page 56).

In a rocket-borne x-ray survey of Centaurus A the NRL group found a flux consistent with 3 K. Although measurements were made at energies from 1 to 10 KeV, the experimenters infer that they are looking at inverse Compton scattering of cosmic-ray electrons in the galaxy from the infrared photons; as a result the photon energy is raised into the x-ray region.

Harwit told PHYSICS TODAY that the NRL conclusion is based on a very specific model of Centaurus A. "Specifically," he said, "the assumed magnetic field intensities could differ by more than an order of magnitude from the assumed values; this affects the conclusion drastically."

Chubb told us that although NRL did assume a specific model, it is a reasonable one because it is based on an electron–proton ratio equal to that observed in cosmic rays on earth and on an equipartition in energy between the particles and magnetic field in Centaurus A. —GBL

Polywater

continued from page 17

(Raman spectra show the symmetric vibrational modes that may not be excited by infrared radiation) of one sample to prove his point. The spectrum had no free OH-stretch band, an omission that supports a polymer structure, and did have what seemed to be a hydrogen band at 1700 to 1800 cm^{-1}. This band, although consistent with the expected hydrogen bonding, is identical with a sodium-nitrate frequency; nitrate had been introduced when the preparation tube was washed with nitric acid, and a crystal of $NaNO_3$ subsequently appeared in the water.

Water II. Boris Deryagin (Karpov Institute of Physical Chemistry, Moscow) has, according to Lippincott, produced samples of anomalous water that are "a lot cleaner than anything we have produced in this country." Deryagin, one of the original champions of "polywater"[3] (which he calls "water II") still believes in its existence and proposes a molecular weight of about 180. He claims that those groups who have found impurities have simply been careless in their preparation.

A significant part of Deryagin's evidence is his distillation data. One end of a sample-containing capillary was heated to 250–300°C while the other end was chilled; the distillate had the same anomalous properties as the original sample. His group also distilled water II across a 700–800°C thermal barrier, and here the distillate had properties indistinguishable from those of "water I" (normal water).

To most of the assembled group, these data were hard to refute. But Alan E. Florin (Los Alamos Scientific Laboratory), who with Sherman Rabideau has also been trying to prepare impurity-free anomalous water, pointed out that boron, a constituent of borosilicate glasses, is volatile in steam. If boron were originally present in the anomalous water, it could be carried along during the 250–300° distillation.

He is generally suspicious, Rabideau later told PHYSICS TODAY, of the distillation data. In a small (10–50 micron) capillary, he claims, the liquid is more likely to "go flying down from one end to the other like a little shotgun slug" or to be transferred along the walls than it is to distill properly. Deryagin had tried to minimize this possibility by widening some of the capillaries before distillation; this attempt, says Rabideau, probably does not prevent film transport along the walls.

Impurities found. Rabideau and Florin have prepared[4] anomalous water in quartz capillaries by two fairly standard methods. They examined weighed residues (the nonvolatile part of the sample, which is believed to be concentrated "polywater") with electron microprobe and neutron-activation techniques, and did boron isotope-dilution studies; they found an average of 6% boron and 5% sodium. They reproduced some of the anomalous-water properties (increased refractive index, long tapered meniscus and a flat cooling curve) with aqueous sodium borate. "We have been unable to make any polywater that did not show the relatively high impurities in the concentrated material. I think the burden of proof now really rests with those who say they have something unusual." His work, Rabideau says, will continue only if and when they get samples from other laboratories.

Denis Rousseau (Bell Telephone Laboratories) has also found a variety of impurities in anomalous water. Rousseau, a spectroscopist, believes that