

It's easy to characterize the ideal memory product; let's call it IRAM. IRAM is: nonvolatile with unlimited read/write cycles, for permanence and reliability; ultra-high-density, to conserve board space; capable of very fast read/write times, for quick data capture and retrieval; and inexpensive, for obvious reasons. At our current level of technology, IRAM is wishful thinking. But there are promising developments in the real world. Researchers are wrestling practical devices from conceptually ideal memory technologies like ferroelectric memory.

Ferroelectric memory is based on the ferroelectric property of certain crystalline materials which have two stable polarization states. A ferroelectric material assumes one polarization state when an electric field is applied (in a memory cell, the material switches when the cell is written to) and remains stable when the field is withdrawn. No external field or current is required for the material to retain its polarization. Using such material, it is possible to build a memory device that can retain memory in a non-powered state; conceptually, an ideal nonvolatile memory.

ADVANTAGES OF FERROELECTRIC RAM

Practically, the specific advantages of ferroelectric random-access memory (RAM) cited by the researchers and manufacturers interviewed are:

- (1) Ferroelectric RAM has high endurance (compared to EEPROM): 10 billion read/write cycles. To put it in more graphic terms, Kerry Maletsky, FRAM Product Manager at Ramtron International, says, "You can read or write this part once every 30 milliseconds - more than 30 times every second - for 10 years, as compared to EEPROM endurance: 100,000 cycles, or about once per hour for 10 years."
- (2) Ferroelectric RAM is fast. "There's no delay when you write to this product," says Maletsky. "It takes 10 milliseconds to write on an EEPROM, but there's no delay with FRAM, and when the power goes away, it's still there."
- (3) When compared to battery-backed SRAM or to a system with EEPROM and a capacitor to maintain the refresh power, ferroelectric RAM costs less.
- (4) Again, when compared to battery-backed SRAM, ferroelectric RAM is smaller and easier to design into small form-factor equipment.

FERROELECTRIC MEMORY RESEARCH

Research in the area of ferroelectric memory has two foci. The first is uncovering or synthesizing more capable ferroelectric materials. PZT (lead zirconium titanate), the material used in the earliest ferroelectric memories, is being improved upon, and in some cases, replaced with newer ferroelectrics, such as Symetrix's Y-1 or ferroelectric BST (barium strontium titanate).

The second focus for ferroelectric research is in process technology and equipment. According to the companies interviewed, US and Japanese researchers are actively working to develop processes for depositing ferroelectric thin films and ensuring reproducible quality in commercial production of ferroelectric ICs. Dr. Carlos Araujo, Chairman at Symetrix Corporation, says that important semiconductor manufacturers are currently developing and testing a lot of basic technology which is still too secret to

announce. A number of new products are in the pipeline, he says, predicting that "major marketing efforts will happen a year from now."

To cover the developmental status and commercial availability of ferroelectric random-access-memory for this report, Electronic Components contacted Ramtron International Corp, Symetrix Corporation, Advanced Technology Materials, Inc, and Micron Semiconductor, Inc.

.....

FERAM: WHAT'S IT GOOD FOR?

Generally speaking, ferroelectric memory can be used in applications such as data recording, bulk storage, core memory replacement, and controller systems which can have power removed and applied without having to reinitialize. Specifically speaking:

* Ramtron's FRAM memory is going into Sega's top-selling video game cartridges, where it replaces a competing nonvolatile memory solution -- a combination of a lithium battery, controller chip, and an SRAM chip. Using FRAM, says Maletsky, provides the ability to "store the state of the game" at any given instant. The market for ferroelectric memory is everywhere. "You name it. Electric utility meters; industrial control and flow meters; automotive uses; cellular phones; printers" and anything where it is important to keep track of quickly changing data.

* Hughes Aircraft is using Symetrix's Y-1 technology in a variety of small-memory military uses. Symetrix licensees also include several major Japanese memory houses. Ferroelectric memory will also be used in microcontrollers for Panasonic electronic products, as part of their "system-on-a-chip" technology.

* Ferroelectric technology allows the use of passive, no-contact tags or cards that are powered by a low-power radio frequency (RF) electromagnetic field. Applications like "smart" electronic tickets good for a specified number of trips, animal identification tags for tracking animals in a wildlife preserve (or in the wild), cards for security access control, or barcoded tags for inventory tracking can use a chip with ferroelectric memory embedded in every card or tag. The cards can then be written to and/or read instantaneously by radio-frequency (RF) units; ferroelectric memory chips retain the data without battery backup or refresh cycles.

=====