Wafers herald new era for computing

Michael Cross, Tokyo, and Susan Watts

ONE of the electronics industry's holy grails is approaching reality thanks to a tie-up between a Japanese computer maker and a British firm founded by the entrepreneur Sir Clive Sinclair. The two companies last week unveiled a wafer of silicon containing more than 200 memory microchips, arranged to function as a single 200-megabit memory. Such "wafer-scale integration" technology could greatly reduce the cost of electronic devices such as computer memories, which today are made up from many individual chips mounted on a circuit board.

Today's microchip factories create circuits by etching rows of identical components on circular wafers of silicon. Another process then slices up the wafers into chips, each bearing one component, which in turn must be mounted on a circuit board for fitting into an electronic device.

For years, electronics engineers have looked for ways to avoid cutting up wafers. Creating a single circuit across a whole wafer would be far cheaper and more convenient than mounting individual chips on boards. This wafer-scale integration process would allow designers to pack electronic circuits more closely together, because there is no need for wires to connect the separate microchips.

A problem with wafer-scale integration is that processes for etching microcircuits on wafers are not perfect. Only a percentage of the chips on a wafer will be flawless (companies keep the exact figures close secrets) and no one knows which part of the wafer will contain flawed components.

The wafer unveiled last week, at the International Solid State Circuits Conference in New York, tolerates these inevitable faults. It is based on an idea from Ivor Catt, a British inventor. Catt spent years trying to sell his ideas to the computer world before attracting the attention of Sinclair. In 1986, Sinclair sold his troubled computer business to his rival, Amstrad, and set up a series of new ventures including Anamartic, a company based in Cambridge, to develop Catt's ideas.

Among Anamartic's backers are Tandem Computer, Barclay's Bank and Fujitsu, Japan's largest computer company, which last year invested £200 million in the company. Fujitsu also turned the concept into a real piece of silicon.

Fujitsu last week said the 15-centimetre wafer contains 202 1-megabit DRAMs, or memory chips, each one connected to a logic circuit. Each logic circuit is connected to the four logic circuits surrounding it.

"Fujitsu has produced 6-inch wafers which it says are working, that is a big achievement because it can now roll them off its production lines. It uses the standard production machinery, the only difference is that these wafers have their 1 M-bit DRAMs spaced slightly wider apart, in order to fit the logic circuits in place between them."

These logic circuits include software which means Fujitsu can bypass the faulty parts of a wafer. The driving current passes across the wafer in a spiral, starting at the edge of the wafer, then back again along the same path.

The result, Fujitsu said, is a single memory of 200 megabits, capable of picking out data 1000 times faster than can magnetic discs. The largest DRAM chips which are mass-produced today hold just 4 megabits of information, although six Japanese companies have developed prototype chips which can store 16-megabits of information.

Fujitsu said the wafer memory would fill the gap between expensive high-speed solid state memories and cheap, but slow, magnetic disc memories for computers.

Catt has now taken out patents on an idea which extends this wafer-scale technology to produce a "smart" wafer, which includes processing power as well as memory. This consists of a two-dimensional array of processors on the same wafer, each with its own memory, to create what Catt calls a "Kernel Logic Machine". He is looking for £5 million to develop his ideas into commercial products. □

Erasable chips improve their memories

RESEARCHERS working for Toshiba, the world's second-largest microchip company, have announced a significant step forward in memory chips.

Toshiba says that it has built a memory chip, called an EEPROM, which is capable of storing 4 million bits of information. Until now, manufacturers have failed to produce chips of this kind with a capacity greater than 256 kilobytes. The company says that its new 4-megabit chips will allow computer manufacturers to dispense with cumbersome rotating magnetic disc drives for storing programs.

An EEPROM chip—an electrically erasable programmable read-only memory—can erase and rewrite its own data, and will keep the data safely when the power is off. This type of memory chip falls halfway between a DRAM (dynamic random-access memory) and an EPROM (erasable programmable read-only memory). DRAMs can locate pieces of information very quickly, but if the power goes off they lose their data. EPROMs will store data almost indefinitely, but it is not easy for users to alter the stored information.

EEPROMs alone have the qualities that solid-state memories will need if they are to replace disc drives as stores for large amounts of information. Each memory cell of an EEPROM, contains a pair of transistors. One stores data and the other acts as a switch. In contrast, a DRAM's cell contains a transistor and a capacitor —a far simpler electronic layout. The difference between an EEPROM and a DRAM is reflected in the amount of memory each chip can contain. For DRAMs, 1 megabit is becoming the standard capacity, and manufacturers are already producing 4-megabit chips.

Toshiba's new design has only one switching transistor for every four memory transistors. **Michael Cross, Tokyo**

Crystal detector gives Britain a map of Chernobyl's fallout

A PROTOTYPE detector developed by researchers in Scotland has provided the British government with the most detailed and accurate picture yet of radioactive fallout from the Chernobyl accident.

The equipment was used for an aerial survey of Cumbria, one of the upland areas of Britain which was exposed to contamination after the disaster in 1986. Levels of radiocaesium have stayed high, and prompted controls on the movement and slaughter of sheep which graze on the affected fells.

The system relies on the fact that variations in the distribution of radionuclides produce variations in the gamma radiation which can be "mapped out" using a sensitive radiation detector mounted in a low-flying aircraft. Scientists working at the Scottish Universities Research and Reactor Centre, at East Kilbride, are behind the technique. The key piece of equipment is a detector built around a lump of crystal of thallium iodine which measures 300 centimetres by 100 centimetres.

As the radioactive elements decay they produce secondary electrons which transfer energy to the crystal to create scintillation pulses, or flashes of light. The pulses are recorded in an analyser which monitors the strength and frequency of each. Different radioactive elements produce electrons with varying energies. These electrons produce pulses in the crystal with their own distinct waveforms. This information, together with navigational data, is logged onto a portable computer.

The researchers conducted the survey last summer, when they took 1800 measurements from an area of over 45 000 hectares. This covered some of the most mountainous country in England, including the highest peak, Scafell Pike, as well as moorland, forests, and low-lying pasture including dairyland. The team chartered a Bell Jet Ranger to make the flights, from a temporary field-base at Wasdale Head.

The technique is known as aerial radiometric mapping. In the past it has been used in uranium and mineral exploration. The technique was last used, in a more primitive form, for radioactive measurement in Britain following the 1957 fire at the Windscale nuclear plant.

Radiometric mapping is used routinely by the American regulatory authorities to monitor exposure to radiation near US nuclear plants. The technique has also been employed to measure radon in the atmosphere. The Swedes have also used the technique to determine the distribution of fallout from Chernobyl.

Ironically, when the Scottish team asked the British government for £500 000 to develop their prototype in 1987, this request was turned down. □