

to compress the plastic case and the chip equally on all sides; there would be no need for great strength because there would be no need to hold back high pressure on one side against low pressure on the other side. A light source suitable for use with the camera could consist of light-emitting diodes (LEDs). Like integrated-circuit chips, LEDs can withstand very large hydrostatic pressures.

If power-supply regulators or filter capacitors were needed, these could be at-

tached in chip form directly onto the back of, and potted with, the imager chip. Because CMOS imagers dissipate little power, the potting would not result in overheating. To minimize the cost of the camera, a fixed lens could be fabricated as part of the plastic case. For improved optical performance at greater cost, an adjustable glass achromatic lens would be mounted in a reservoir that would be filled with transparent oil and subject to the full hydrostatic pressure,

and the reservoir would be mounted on the case to position the lens in front of the image sensor. The lens would be adjusted for focus by use of a motor inside the reservoir (oil-filled motors already exist).

This work was done by Thomas Cunningham of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30774

RFID and Memory Devices Fabricated Integrally on Substrates

These molecularly bonded devices would be much thinner than microchips.

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Electronic identification devices containing radio-frequency identification (RFID) circuits and antennas would be fabricated integrally with the objects to be identified, according to a proposal. That is to say, the objects to be identified would serve as substrates for the deposition and patterning of the materials of the devices used to identify them, and each identification device would be bonded to the identified object at the molecular level. Vacuum arc vapor deposition (VAVD) is the NASA-derived process for depositing layers of material on the substrate.

This proposal stands in contrast to the current practice of fabricating RFID and/or memory devices as wafer-based, self-contained integrated-circuit chips that are subsequently embedded in or attached to plastic cards to make "smart" account-information cards and identification badges. If one relies on such a chip to store data on the history of an object to be tracked and the chip falls off or out of the object, then one loses both the his-

torical data and the means to track the object and verify its identity electronically. Also, in contrast is the manufacturing philosophy in use today to make many memory devices. Today's methods involve many subtractive processes such as etching. This proposal only uses additive methods, building RFID and memory devices from the substrate up in thin layers. VAVD is capable of spraying silicon, copper, and other materials commonly used in electronic devices. The VAVD process sprays most metals and some ceramics. The material being sprayed has a very strong bond with the substrate, whether that substrate is metal, ceramic, or even wood, rock, glass, PVC, or paper.

An object to be tagged with an identification device according to the proposal must be compatible with a vacuum deposition process. Temperature is seldom an issue as the substrate rarely reaches 150° F (66° C) during the deposition process. A portion of the surface of the object would be designated as a

substrate for the deposition of the device. By use of a vacuum arc vapor deposition apparatus, a thin electrically insulating film would first be deposited on the substrate. Subsequent layers of materials would then be deposited and patterned by use of known integrated-circuit fabrication techniques. The total thickness of the deposited layers could be much less than the 100- μ m thickness of the thinnest state-of-the-art self-contained microchips. Such a thin deposit could be readily concealed by simply painting over it. Both large vacuum chambers for production runs and portable hand-held devices for *in situ* applications are available.

This work was done by Harry F. Schramm of Marshall Space Flight Center.

This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.a.nabors@nasa.gov. Refer to MFS-31549.