TECHNOLOGY

Liquid crystals, move over

This quick-change artist has a memory. Called hydrated iridium oxide, it switches from transparent to opaque blue-black in a fiftieth of a second when stimulated by a brief electrical pulse. That's roughly the switching time of liquid crystals, say IBM physicists experimenting with thin (1,000 angstroms) films of the electrochromic material. But unlike liquid crystals, whose images fade rapidly, this compound holds its image without refreshing for more than five hours. So while it's likely to cost no more than liquid crystals, its "memory" will make it an energy saver when holding an image. Being less sensitive to temperature and offering a wider viewing angle, it may also spell the answer to inexpensive, energy-efficient outdoor display screens.

Encoding an explosive business

Nabbing terrorist bombers is a difficult business. But work on a system to "scent" and "fingerprint" commercial chemical explosives could leave most forensic bloodhounds at least a whiff of clues with which to begin their hunt. Under development are taggants, additives manufacturers dope explosive materials with to aid in both the detection and identification of bombs.

They come in two varieties. Detection species pack microcapsules of perfluorinated-cyclo-alkane compounds that time-release easily detected vapors. Portable mechanical "sniffers," such as mass spectrometers and electron-capture detectors, could track down hidden bombs before they go off. Alternatively, mounted versions could screen entrants to high-risk areas much as airport X-ray equipment now scans hand-held luggage. Designed to survive detonation, identification species include materials coded to identify the batch — and presumably also the last legal consumers of a manufacturing batch. A jacket of special materials aids in their retrieval from rubble with magnets. Coating the sand-sized particles with phosphors causes them to glow under ultraviolet light — a boon to finding tags the size of a needle's eye in the dark.

Proposed legislation would require taggants in all explosives (even gunpowder). But a 172-page draft by the Congressional Office of Technology Assessment reported last week that there were still unresolved issues. For example, depending how frequently codes change — annually, per shift, or per 2,000 to 10,000 pound batch — cost of identification coding could run users between $80 million and $268 million yearly, the report says. For detection systems, finding a "happy compromise between cost and sensitivity" in detectors is the big issue, says Quon Kwan of Aerospace Corp., the firm supervising much of the Treasury Department's taggant-development program.

OTA says 3M Co.'s microplastic chips, color-coded like electronic resistors, are the leading contender in identification tags. Yet Kwan says their insertion in hot explosives has occasionally caused discoloring and deterioration, a sign of reactivity. And it's feared that the potential abrasiveness of magnetically coded taggants — composed of combinations of ferrites, each with its own Curie point (the temperature where a particle loses its magnetism) — could cause premature detonation.

Quick timing

If punctuality is essential, Johns Hopkins University's Applied Physics Laboratory has the ticket. It's a hydrogen maser (microwave amplification by stimulated electromagnetic radiation) clock that won't lose more than a millionth of a second in three years. Its stable, trillionth-second accuracy is important in precision surveys over thousands of miles, in navigating deep-space probes and in measuring the performance of atomic clocks and other precision oscillators.

PHYSICAL SCIENCES

Dietrick E. Thomsen reports from Washington at the meeting of the American Physical Society

Consider the muon

Physicists were considering the muon before I. I. Rabi made his famous remark: "Consider the muon. Who ever ordered that?" They still haven't found out who ordered it.

What Rabi was getting at is that the muon seems to be an almost perfect and highly unnecessary copy of the electron except for mass. The muon's mass is 260 times that of the electron.

One characteristic the muon and the electron share is the ability to respond to electromagnetic forces and to those of the weak subnuclear interaction, but not to those of the strong subnuclear interaction. Very few particles escape the strong interaction.

Suppose the muon in fact responds to the strong interaction ever so slightly? That would be a significant difference from the electron, and it might possibly point the way to an answer to Rabi's question. The forces can be studied in the so-called pi-mu atoms, structures in which a pion and a muon are bound together by electric forces like a conventional atom. The pion is a good source of strong interaction forces, so if those forces work on the muon too, that fact should be evident.

Because of the instability of both constituents pi-mu atoms have a fleeting existence. The best way to get them is ready-made from the decay of another particle, the kaon. A pi-mu atom is produced once in two million kaon decays. By setting up the world's most intense kaon beam, a group led by Gordon B. Thompson of the University of Wisconsin working at the Fermi National Accelerator Laboratory managed to record 300 pi-mu atoms in three months. Theory predicts 293. Thompson pronounces the agreement good. If the strong force had been acting, the number should have been different. The muon still has to be considered.

While the flavor lasts

The discovery of the so-called charm particles in 1974 was widely acclaimed as a beautiful example of experiment finding something that theory needed. The existence of charm, this fourth basic property or "flavor" of subatomic particles, was needed for a coherent description of the particles then known and the three flavors manifest in them: up, down and strange.

To find out just how completely the charm particles fit what theory needs, it is necessary to measure their lifetimes. An experiment to do this was performed at the Fermi National Accelerator Laboratory by a group from Japan, Canada, the United States and Korea. It was reported by David Bailey of McGill University in Montreal, Steven Errede and Michael Gutzwiller of Ohio State University and Dale Pitman of the University of Toronto.

Particle physicists work generally with three varieties of force: electromagnetism and two varieties peculiar to the subatomic domain — the "strong" and the "weak" forces. The existence of charm was postulated to explain the behavior of the flavor called strangeness in certain procedures governed by the weak force.

Being weak, the weak force is also slow. Under its influence charm is expected to turn itself into strangeness or some other flavor, but only after a while. Thus, particles containing charm should live a long time. The mean lifetimes of four charm particles were measured: for the D^0 1.2×10^{-13} seconds, for the D^+ 10.0×10^{-13}, for the F^+ 2.2×10^{-13}, for the lambda-c-plus 1.1×10^{-13}. This may seem extremely instantaneous, but particle lifetimes can be a million- even a billion-fold shorter.

Nevertheless, it's not exactly what theory predicted. The experimenters say that suggests that more theoretical work needs to be done, but that the status of charm as a fourth "fundamental building block of nature" must be regarded as established.