Physics

New heights in fusion power

On May 27, researchers at the Princeton University Plasma Physics Laboratory achieved record levels of controlled fusion power. Using a magnetically confined plasma made up of a half-and-half mixture of deuterium and tritium, the Tokamak Fusion Test Reactor (TFTR) generated a burst of 9 million watts of power, besting the previous record of 6.2 million watts established last December at the same facility (SN: 1/1/94, p.12). The new power level was maintained for 240 milliseconds. The plasma temperature reached 460 million kelvins.

PPL

Interior view of the Tokamak Fusion Test Reactor

The sequence of experiments leading to this record furnished additional evidence that energetic alpha particles created by the fusion of deuterium and tritium nuclei deposit energy into the plasma and increase its temperature (SN: 5/28/94, p.341). The existence of this effect improves the prospects of eventually obtaining a self-heating plasma, a crucial step toward commercial fusion power.

Researchers will try to reach at least 10 million watts before the TFTR is shut down and dismantled, an operation scheduled to start at the end of September to make way for an advanced fusion reactor known as the Tokamak Physics Experiment. The new reactor is designed to generate fusion power continuously rather than in bursts.

Birth and death among chemical blobs

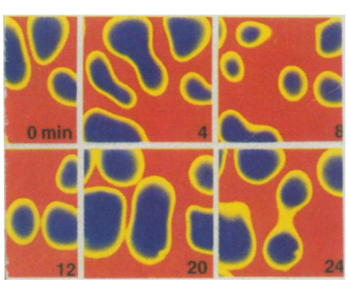
Behaving like a zoo of living cells, the spots created in a simple chemical mixture grow, divide, and when overcrowded, die. Representing little pools of low acidity in an acid bath, these spots continue their activity as long as fresh chemicals are fed into the system.

The discovery of this behavior in the laboratory represents an intriguing extension of the types of patterns observed when different, continuously supplied chemicals react and the reaction products diffuse through a gel or some other medium (SN: 5/9/92, p.311). Kyoung-Jin Lee, William D. McCormick, and Harry L. Swinney of the University of Texas at Austin describe their experiments in the May 19 NATURE.

"These are dynamic patterns that have not been seen before," Lee says. But there is no evidence that this chemical behavior is directly linked to any biological system.

The researchers produced the patterns in a thin, transparent gel continuously fed with a fresh solution containing sulfuric acid and iodate, sulfite, and ferrocyanide ions. Interactions among the reacting chemicals and the diffusing reaction products created well-defined regions of low acidity.

At low ferrocyanide concentrations, intricate, mazelike patterns appeared. At higher concentrations, blobs showed up, which sprouted and sloughed off new blobs. The observed patterns closely resembled those generated in earlier computer simulations of the chemical reaction, done by John E. Pearson of the Los Alamos (N.M.) National Laboratory.



Lee et al./NATURE

Computer-colored images of chemical self-replicating spots in a thin gel. Blue areas correspond to regions of low acidity, red to high acidity. Each image represents a patch of gel 7 millimeters wide.

Chemistry

Fullerenes from space?

Buckyballs – the 60-carbon buckminsterfullerenes known for their soccer ball shape – may occur naturally in space, according to two research groups.

The recent reports offer data supporting the contention that the spherical carbonaceous shells, known to occur naturally on Earth, can also form in the inky void of space.

In the May 5 NATURE, Filippo Radicati di Brozolo, a space scientist at Charles Evans and Associates in Redwood City, Calif., and his colleagues describe finding fullerenes among carbon residue in a tiny impact crater on NASA's Long-Duration Exposure Facility after that spacecraft's return to Earth.

The scientists believe that the crater – roughly 100 micrometers in diameter – formed when a chondritic micrometeoroid struck the craft at high velocity, leaving a dent in an aluminum panel near its leading edge. Inspecting the carbon residue with laser ionization mass spectrometry and Raman spectroscopy, they saw evidence of fullerenes. Further tests to determine whether fullerenes can survive such high-velocity impacts into aluminum showed that they can. Moreover, the scientists found no indications that the buckyballs formed as a result of handling or contamination.

Even if further study shows that the impact itself produced the fullerenes, the researchers say, "this suggests a viable mechanism for fullerene production in space."

In the May 26 NATURE, B.H. Foing and P. Ehrenfreund of the European Space Agency and the Leiden Observatory, respectively, both in the Netherlands, report observing fullerene spectra in the near-infrared light of seven stars.

Specifically, the scientists found two spectral bands that resemble those from fullerenes made in the lab. On the basis of their measurements, they estimate that 0.3 to 0.9 percent of all interstellar carbon could exist in fullerene form.

For many years, scientists have observed more than 100 well-defined absorption bands in the visible and near-infrared ranges, which arise from diffuse interstellar gas. They have suspected that fullerenes play a role in those spectra, but until recently they had only weak evidence. These new data, though not definitive, buttress the belief that buckyballs do exist naturally in interstellar space.

Better scrubbers

Giant industrial plants and utilities signal their presence with tall smokestacks that belch nasty fumes into the air.

To tame the mighty stacks, environmental regulations mandate the use of scrubbers to lessen the amount of sulfur dioxide and nitrogen oxide emitted into the air when fossil fuels are burned. Both of these gases contribute to urban smog and damaging acid rain.

But scrubbers suffer from some imperfections. To soak up effluent sulfur dioxide, they use wet limestone. But water-insoluble nitrogen oxide must be removed separately, by means of other, less efficient catalytic reactions.

Now, scientists suggest an alternative cleansing method. Eric K. Pham and Shih-Ger Chang, both chemists at the Lawrence Berkeley Laboratory in Berkeley, Calif., describe in the May 12 NATURE a way to alter wet-limestone scrubbers so that they can remove both gases in one step.

The chemists propose using a new iron-based compound, called iron(II) thiochelate, that makes nitrogen oxide dissolve more readily in water. By absorbing the nitrogen oxide gas, the compound forms an iron nitrosyl complex that can be converted into ammonia, thus liberating the iron catalyst for further use.

This process could also save money, the chemists estimate. In fact, the new technique could cost as little as $390 per ton of nitrogen oxide removed, compared to the $2,000 to $4,000 per ton price tag of current methods.