Their composition and energies, says McKibben, should provide clues about how they're generated in such tumultuous environments as supernovas and "how much time they've spent knocking around in the interstellar medium."

McKibben's hopes rest on the assumption that the magnetic field of the sun really will be simpler at the poles—and among Ulysses' nine other experiments is one that will test that assumption directly, by measuring the field's structure. Other instruments, sensitive to x-rays, will exploit the polar vantage to take a sideways look at solar flares, in an effort to learn the anatomy of these powerful eruptions. Still others will study radio waves from the sun, dust and gas particles from outside the solar system, and the mysterious cosmic explosions called gamma-ray bursts.

The scientists running all those experiments back on Earth are a disparate lot, but there's one thing uniting them: the hope that Ulysses won't be shut down as currently scheduled, in September 1995, after it finishes its pass over the sun's north pole. "We're very keen to extend the mission," says Smith. He and his colleagues are appealing to NASA headquarters for another 6 years—enough for Ulysses' long orbit to carry it baxck over the poles. By then the sun, at the peak of its 11-year activity cycle, will be a very different star from the quiescent one Ulysses will see on its first pass. And the year will be 2001—a fitting time, Ulysses investigators think, to continue their space odyssey.

–Tim Appenzeller

MEETING BRIEFS

User-Friendly Chemistry Takes Center Stage at ACS Meeting

These days it seems that what chemistry needs more than anything else is a good p.r. agent. If you ask John or Joan Q. Public about the accomplishments of the chemical industry, chances are they'll mention Love Canal, CFCs destroying the ozone layer, or carcinogens in food. On the public confidence list, chemists probably rank somewhere above lawyers and politicians–but that's not saying much. However, if the national meeting of the American Chemical Society in Washington, D.C., 2 weeks ago is any indication, chemists are working hard to fix the image problem. Nearly all of the two dozen press conferences held during the meeting focused on food, health topics, environment-friendly technology, or some other subject close to consumers' hearts. And the scientific talks themselves reflected the same interests, with sessions such as "Environmental Successes in the Chemical Industry" and "Food Phytochemicals for Cancer Prevention" (*Science*, 4 September, p. 1349) taking their place alongside "Chemistry of Electrophilic Metal Complexes" and "New Advances in Polyolefin Polymers."

Zapping Acid Rain With Microwaves

Chang Yul Cha of the University of Wyoming in Laramie is an example of the new, environmentally sensitive chemist. Cha has found a cleaner, greener way to remove sulfur dioxide and nitrogen oxides from coal-fired smokestacks—and so reduce acid rain. Current schemes for cleaning smokestack emissions, such as limestone scrubbers, are expensive and create other wastes, such as sludge, which must themselves be treated. Cha's process, which relies on microwaves and char, a charcoal-like substance created by anaerobically heating coal, produces only nitrogen, sulfur, and carbon dioxide.

The first step is to pass the sulfur dioxide and nitrogen oxides through a bed of activated char, where the gases are absorbed into the char's tiny pores. Cha then zaps the char with microwaves, heating it and stimulating a reaction between the gases and the carbon atoms in the char. The resulting nitrogen and carbon dioxide are released into the atmosphere; the sulfur is cooled in a spray chamber and collected for sale.

Even the char becomes a product in this thrifty scheme. Cha adds powdered coal to the char-gas mixture, and the heat in the reaction chamber turns the coal into more char. This char is used again and again, becoming more activated (more porous) with each cycle, until after about 40 cycles it can be removed and sold for use in filtration, such as in waste-water treatment plants.

Cha says his scheme decomposes about 98% of the sulfur dioxide and 90% of the nitrogen oxides that pass through it—more than conventional scrubbers. Even better, he says, it will be cheaper than existing methods once the income from selling the activated char is taken into account. Soung Kim, a Department of Energy project manager who funded Cha's work, agrees, saying the technique is "technically and economically feasible and has the potential to be highly efficient and cost effective." Since the 1990 Clean Air Act requires industry to reduce sulfur dioxide emissions by 10 million tons a year by 2000, Kim says that Cha's technique is likely to get a close look and could be in use somewhere in the United States by next year.

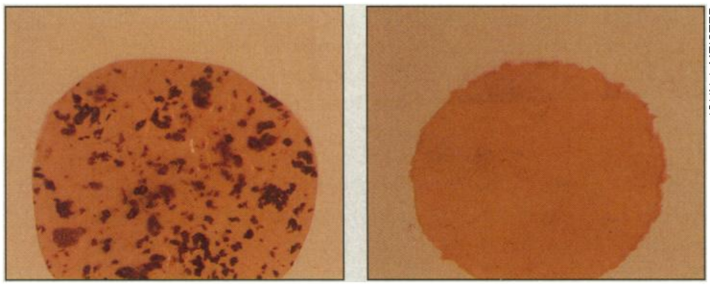
Wooden You Love Biodegradable Plastics?

Paul Gatenholm of Chalmers University of Technology in Götenborg, Sweden, has targeted another of society's unwanted byproducts: solid waste. His point of attack is plastics, which make up only a small percentage of the materials going into landfills but pose a disproportionate problem because they are mostly not biodegradable. One exception is polyhydroxybutyrate-hydroxyvalerate, or PHB-V, which is produced commercially in vats of bacteria and is broken down in the environment by naturally occurring microbes (*Science*, 15 September 1989, p. 1187). The problem is that PHB-V is too expensive to replace conventional petroleum-derived plastics except for special uses.

By combining PHB-V with wood fibers, a natural biodegradable material, Gatenholm has come up with a lower cost alternative he calls a "compostable composite." And as reported at the meeting by another chemist, John Meister of the University of Detroit Mercy in Detroit, the same hybrid strategy can be used to improve other properties of plastics as well, to make them into more useful as well as more environment-friendly materials.

Getting the cellulose of wood to mix with plastic wasn't easy, Gatenholm and Meister say, because cellulose is hydrophilic (it mixes well with water) and plastic is hydrophobic (it repels water). Gatenholm, however, discovered a processing technique that does blend the cellulose and PHB-V—although he still hasn't figured out what happens at the molecular level to make them compatible. The resulting composite will decompose completely in a composting system, Gatenholm says. He pictures it being used in such products as diapers and food containers, which can't always be recycled because of contamination.

Meister took a different path to a similar end. In creating his wood-plastic composites, which he calls "fiberwood" by analogy with "fiberglass," Meister was searching not so much for a biodegradable material (although he says his fiberwood can be made to decompose in the environment) as for a cheap way to strengthen ordinary plastics. The wood fibers, he thought, would act like the glass fibers in fiberglass, adding strength and tear resistance to the original substance.



JOHN J. MEISTER

Good bonding. Wood fibers simply mixed with plastic bunch up and weaken the material *(left)*, but a "grafting reaction" disperses them to yield a strong composite *(right)*.

Like Gatenholm, Meister found that his major obstacle was getting a good link between wood fibers and plastic. When the two are combined, the wood fibers tend to bunch up, creating weak points where the resulting mixture will crack and pull apart. To solve the problem, he developed a reaction that grafts molecular chains of the plastic onto the wood fibers like tiny hairs growing off the wood. These plastic-coated wood fibers mix well with more of the plastic, combining to form a composite that Meister says is three times as strong as the plastic alone. It's also lighter, since wood weighs only about 40% as much as plastic.

Potential applications for his wood-plastic hybrid, Meister says, include car bumpers and fenders, heavy plastic wrap and food containers, and substitutes for some of the heavier and more expensive fiberglass products. Besides being lighter and potentially less expensive than the plastics it would replace, Meister's fiberwood also offers an environmental payoff: Substituting wood fibers for up to 40% of the oil-derived plastic would replace a limited resource with one that literally grows on trees.

Modern Alchemy

John Meister is not alone. Chemists in a number of laboratories have set their sights on the 21st-century equivalent of the alchemists' dream of turning base metals into gold: transforming wood and plant fibers into industrial chemicals that could take the place of oil in plastics and other products. At the University of Waterloo in Ontario, for instance, chemical engineer Desmond Radlein and his colleagues have developed a transmutation method that the old alchemists would certainly have appreciated: By heating wood fibers to several hundred degrees for just 2 seconds, Radlein's group creates a polymer-rich oil that can be refined much like petroleum to produce the raw materials for a variety of plastics.

Radlein had set out to find a way of breaking the chain-like cellulose molecules of wood into their chemical units, or monomers, which could then be modified and reassembled to form new polymers with made-to-order properties. Just heating the wood in a normal atmosphere won't do; it catches fire, leaving little of value. But if the wood is pretreated to remove its potassium, sodium, and other alkaline ions and then heated with no oxygen present, the wood breaks down into gases, a solid residue, and a liquid component rich in the monomers that make up cellulose.

Up to half of the liquid consists of levoglucosan, a chemical closely related to sugar that can be used to produce plastics, pharmaceuticals, and even low-calorie fillers for foods. A company in Waterloo is already working to commercialize this technology, Radlein says, with the goal of making levoglucosan into a commodity product that might pose some competition for petrochemicals.

In Search of a Better French Fry

Alongside the sessions devoted to reducing pollution, finding substitutes for petroleum and other worthy but rather abstract goals were a few talks you could really sink your teeth into, such as David Stark's plans for making better french fries. Stark, a chemist at Monsanto Co. in St. Louis, described how he and co-workers inserted a starch-producing gene from the common intestinal bacterium *E. coli* into potatoes, creating tubers that have up to 20% more starch than the best potatoes now on the market.

The increase in dry matter doesn't matter much if you're just going to bake or boil the potatoes, Stark said, but it does make a difference when the potatoes go into the frying pan. Frying replaces the water in the potatoes with oil, so less water content means less oil, resulting in fried potatoes that are more nutritious and take less energy to cook (since much of the energy needed to fry potatoes actually goes into removing the water). Potato chips, for instance, are usually about 36% oil, Stark said, but if made from his new, improved potatoes they would contain only about 30% oil. The improvement is big enough—at least in terms of p.r., if not nutrition—that he expects potato chip manufacturers and fast food companies that serve french fries to switch over.

LUIS CASTANEDA/THE IMAGE BANK

Room for improvement? A bacterial gene yields starchier spuds.

The potatoes have already been grown in field tests under commercial conditions with no problems, Stark said, and he and other Monsanto scientists and managers have taste-tested them—fried, with a little salt and catsup. "They were very good," he reports. If Monsanto can get federal approval for these genetically engineered potatoes to be used in food products, says Stark, look for genetically starchier potatoes in your Lay's potato chips and McDonald's french fries in the late 1990s.

Composting: Healthy Ferment

For those environmentally conscious people who throw their uneaten french fries and biodegradable plastics into a compost heap in the backyard or send them to a municipal composter, Jeffrey Eberhard has good news: Composting is safe. Eberhard, a chemist at the University of Cincinnati, was hired by the city of Cincinnati to determine if composting is a safe alternative to putting waste in a landfill. The city fathers were worried: Besides household garbage, municipal compost facilities generally accept yard waste, which often contains pesticides, and sewage sludge, which can have heavy metals from industrial facilities. Could this brew turn hazardous as it breaks down?

After mixing a variety of compost "recipes" and testing them for both organic and inorganic hazards, Eberhard gives composting a clean bill of health. The metals generally seep throughout the mixture and become bound to other compounds that neutralize their threat, he says, and the pesticides get broken down into much safer materials. Backyard composting should be even safer, Eberhard reports, since household piles don't contain sewage sludge.

Even a taste of backyard compost, such as a small child might try, should be relatively harmless, Eberhard says. In a compost pile made up of yard waste and household garbage, the levels of harmful chemicals and microbes known to be able to infect humans were below the level of detection. It's good to know that in a world where everything seems to cause cancer or harm the environment, it's still possible to pile up some leaves and banana peels in the backyard without worrying about it.

–Robert Pool