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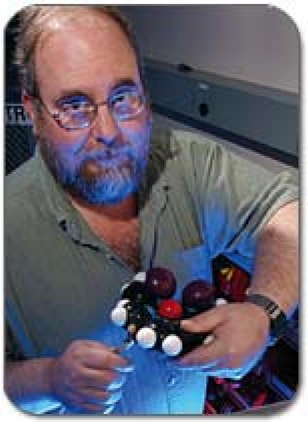
Faculty Focus

Molecules Are His Medium

From artificial noses to ultrasound-induced bubbles, Ken Suslick sculpts his niche in chemistry.



Before you meet the man, you meet the masks. Tribal masks by the dozens cover the sleek white walls of Ken Suslick's office in the Chemical and Life Science Laboratory—masks of wood, metal, or feathers, with faces that are impassive, fierce, or funny. "Mine's the one on the pike," he says, "in the middle of the wall behind you." Suslick points to a small bronze with an inscrutable expression. The chemistry professor casts bronzes in his off hours. But by day in the chemistry lab, molecules are the medium. "A lot of what we do is molecular sculpting," he says.

Suslick is a William H. and Janet Lycan Professor of Chemistry and a professor of materials science and engineering. In his 26 years at U of I, he has proven himself a virtuoso at sculpting molecules, which are less than one-billionth of a meter in diameter, or less than one ten-thousandth the width of a human hair. He invents new molecules, probes how they react, and creates new materials from them. The results: 234 journal articles, 12 patents, 4 books, 2 startup companies, and laurels from the National Science Foundation, the Materials Research Society, and the American Chemical Society, to name just a few.

Suslick is "one of our most creative scientists, and he's made a significant impact in no fewer than three completely different areas of chemistry," says Greg Girolomi, chair of the Department of Chemistry. In his work on molecules called porphyrins, Suslick's team has shed light on the chemistry that allows blood to carry oxygen to tissues and helps the liver detoxify drugs and carcinogens. They've developed an artificial nose that sniffs airborne chemicals. But Suslick is most widely known in the scientific world for his surprising discoveries on how ultrasound drives chemical reactions, Girolomi says. You could even say that ultrasound gave birth to Ken Suslick's career.

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Almost all young chemists apprentice as postdoctoral fellows with a senior chemist before applying for tenure-track faculty jobs. Not Suslick. In 1978, as he was finishing his PhD dissertation at Stanford University, he applied directly for faculty positions at the U of I, Harvard, and several other universities with top chemistry departments.

While searching for a worthwhile research topic, he read a short journal article suggesting that intense sound pitched higher than humans could hear—ultrasound—could alter chemical reactions. He asked about 10 Stanford chemistry professors if they thought it was plausible. "Several told me point blank that there was no possibility that ultrasound could do anything chemical," he recalls. He proposed the research anyway—a choice that cost him a job offer from Harvard. But the U of I gambled on the bold young chemist.

Suslick, in turn, had joined a top-notch department with a long history of groundbreaking discoveries. Legendary U of I organic chemist Roger Adams, for example, had invented ways to synthesize dozens of new chemicals, including a reaction called catalytic hydrogenation that's used today to manufacture everything from drugs to ice cream. Ten Nobel laureates are among the current and former faculty and students. The department consistently ranks among the nation's top six chemistry departments, and it has for decades.

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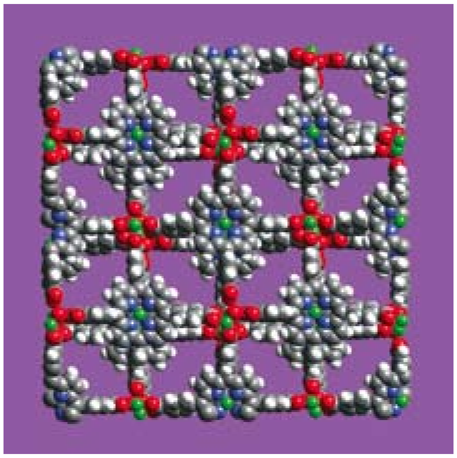

Solid arrays of metalloporphyrins, a type of metal-containing dye, act as chemical sieves for controlling molecular reactions.

The basis of Suslick's artifical nose is a 1-square-inch array of 36 dyes that change color in predictable ways depending on the chemicals and odorants that are present.

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In his office, Suslick leans back in his chair and stretches his legs. He's a solidly built man with a large, bearded face, and he speaks evenly and deliberately with the air of someone who's used to being listened to. Intense sound, he explains, causes liquids to alternately expand and compress, which forms bubbles that grow, then collapse violently. That phenomenon—*cavitation*—erodes speedboat propellers, produces the sound of babbling brooks, and enables depth charges to punch holes in submarines.

In recent papers published in *Nature* and other top journals, Suslick's team has shown that the collapsing bubbles reach temperatures like that at the sun's surface, and pressures like that at the ocean floor—and it's all over faster than a lightning bolt. They're so hot they emit light. "You can see this glowing little bubble in a round-bottom flask. It dances and jitters around." As he shares this little-known secret of nature, his eyes light up, and a small smile appears on his lips.

As it turned out, Suslick's early hunch was right: a lot of chemistry can happen in and around the imploding bubbles. In recent years, his team has used the ultrasound-induced bubbles as tiny crucibles to make metal catalysts that can clean up gasoline by removing environmentally harmful sulfur. They've used it to answer fundamental questions about superconductors—materials that conduct electricity without heating up the way normal copper wires do. They've used it to make tiny, hollow spheres of protein that deliver taxol to tumors. (The tiny drug capsules are being tested in advanced clinical trials.) Dozens of other researchers study what is now known as sonochemistry. Ken Suslick "almost singlehandedly founded this field," Girolomi says.

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Suslick's willingness to explore untrod scientific ground—and a bent for following his hunches—also enabled his team to turn a handful of metal-containing dyes into the world's most effective artificial nose. Chemists had long known that chemicals that bind metal ions almost always have strong smells, and that ring-shaped iron- or zinc-containing dyes called *porphyrins* often change color when chemicals with strong odors bind to them.

One evening in 1996, Suslick was having dinner with prospective graduate student Neal Rakow at a local steakhouse, when Rakow asked a tough question: What would he actually work on if he decided to join Suslick's lab. Suslick realized that they might be able to use the color changes to develop an artificial nose. "The idea sprang out fully formed," Suslick recalls, "like Athena from the head of Zeus."

Four years later, the researchers reported on a method they call "smell-seeing," in which each chemical induces an array of 12 different porphyrins to change colors in a characteristic pattern. Smell-seeing can also measure how much of a chemical is present. That could help detect early signs of stomach ulcers, respiratory infections, and lung tumors, and distinguish expensive perfumes from counterfeits. It could also ask, "Is that nerve poison in the subway or somebody's lunch from three days ago?" Suslick says.

All that from some metal-containing dyes and a thorough knowledge of molecules. "Everything around you is chemistry," says Suslick. "Biology is chemical at its core. You can't even watch television without hearing about chemical imbalances in your brain. Cooking is chemistry. Medicine is chemistry. Agriculture is chemistry. That's what's exciting about it."

But the best parts are molecules that have yet to be sculpted. "The real fun in science," Suslick says, "is learning something that nobody else ever knew."

By Dan Ferber, July 2004
Photo by Thompson-McClellan

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