SCIENCE NEWS

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THIS WEEK

RESEARCH NOTES

ARTICLES

COVER: False-color image of Saturn, photographed by Voyager 2 from 6.5 million kilometers away, shows the planet's rings (with clouds visible through the Cassini division) and their shadows (the two widest dark bands), as well as angled cloudtop features suggesting strong windshear. (The two dark circles are dust rings on the camera lens.) For more of Voyager 2's spectacular findings, see p. 148. (Photo: NASA)

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SCIENCE NEWS OF THE WEEK

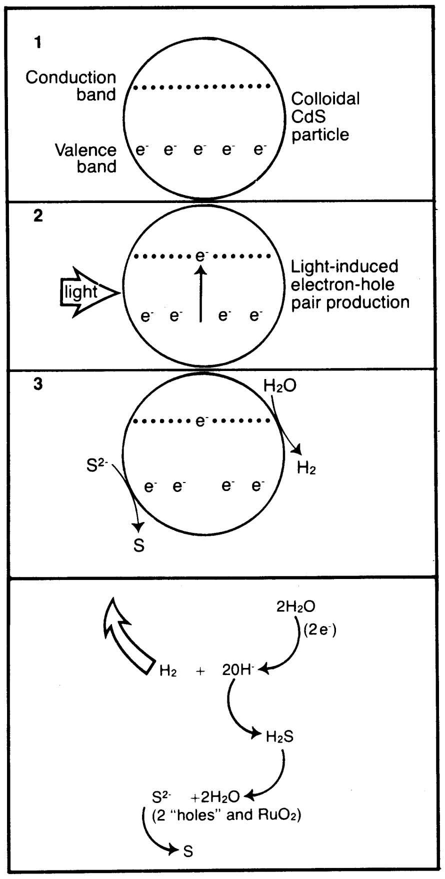
Light Cleaves H_2S: A Profitable Split?

Michael Grätzel had a few stops to make on his way to the recent International Union of Pure and Applied Chemistry (IUPAC) meeting in Vancouver, British Columbia. Apparently, several major oil companies in California are interested in a new process developed by this Swiss researcher and his colleagues. Essentially, the process uses light to split an oil-refinery waste into a potential fuel and a marketable element. The story of the development of this process — that Grätzel claims is "very simple, uses very cheap materials and goes at high yields" — may some day be a chapter for the alternative-energy annals. It is a story about what Grätzel believes will be his "first real money-making" discovery. And it is a story that this go-getter says is full of "big surprises."

It all began last fall when oil company representatives told Grätzel of their trials and tribulations with hydrogen sulfide (H_2S) — a pollutant in refinery gases and wastes of certain industrial operations. Certain crude oils contain sulfur, in the form of H_2S, that must be removed during the refinery process, explains Grätzel of the Federal Polytechnic College in Lausanne. "The amount of hydrogen sulfide that is presently extracted is enormous," he says. "It is on the order of 2.3 million tons per year in the United States." What the oil companies now do with H_2S is to convert its hydrogen component to water and its sulfur component to calcium sulfate — a secondary pollutant. "What is not done at the moment is to make use of the hydrogen [a potential fuel source] contained in the hydrogen sulfide," Grätzel says. "They [oil refineries] simply oxidize it to water, which is a hell of a waste."

Grätzel left his conversations with oil company representatives with no intention of giving their H_2S problem his immediate attention — he was too deeply immersed in his own water-splitting research (SN: 8/16/80, p. 103; 7/18/81, p. 39). One day, however, he inadvertently failed to remove all of the H_2S involved in the preparation of the colloidal cadmium sulfide (CdS) particles used in his water-splitting system. "Now comes the first big surprise," Grätzel told SCIENCE NEWS at the IUPAC meeting: The H_2S-contaminated water-splitting system produced more of the potential fuel hydrogen than did his normally uncontaminated system. Grätzel immediately joined forces with Ezio Pelizzetti of Turin University in Italy to refine the fortuitous H_2S-splitting system.

The developed system uses the same semiconductor CdS particles in Grätzel's water-splitting process. This time, however, the particles sit in a solution of water *and* H_2S. When light strikes these semiconductor particles, excited electrons are promoted to the usually empty conduction band, leaving behind positive (+) "holes" in the usually electron-filled valence band (refer to diagram). This is where the cleaving begins. First, the promoted electrons split water to hydroxide ions (OH^-) and the sought after hydrogen (H_2). The hydroxide ions in turn steal the hydrogen from H_2S to form sulfide ions (S^{2-}) and to reform water. Finally, the positive charges in the valence band convert the sulfide ions to sulfur (S). The system therefore consists of the splitting of H_2S mediated by the splitting of water.



Its "surprising" advantages over the previous system that splits only water, says Grätzel, are as follows: No catalyst is needed, as is usually the case, for the splitting of water; oxygen does not interfere with the reaction, so the system can be run in open air; ruthenium dioxide (RuO_2) *greatly* enhances the transfer of positive "holes" to the solution.

While Grätzel already has interested several major oil companies in his H_2S-splitting scheme, its development, he admits, is still in "the early stages." Nonetheless, "It's a pretty exciting thing," he says. "It's an important contribution to the field of alternative energy resources — it provides a means to make use of a pollutant waste product that has up until now been thrown away." □