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A Facelift For Fossil Fuel

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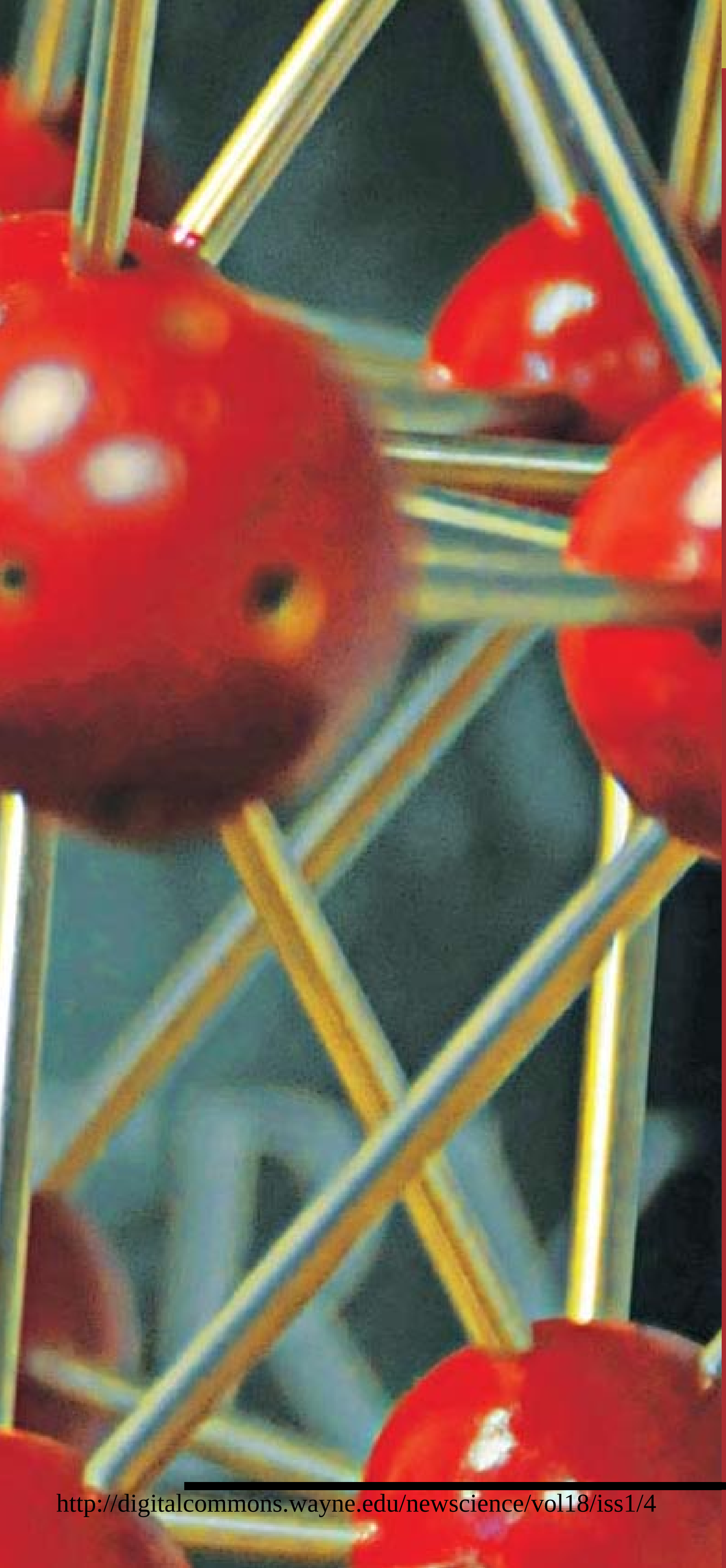

Safer Energy

A facelift for fossil fuel

by Amy Oprean

As scientists around the world scramble to develop a viable alternative to fossil fuels, one Wayne State researcher is working to improve the traditional oil refining process for a cleaner, more securely-obtained gasoline.

Stephanie Brock, Ph.D., professor of chemistry in the College of Liberal Arts and Sciences, is working as a co-investigator with Mark Bussell, Ph.D., professor of chemistry at Western Washington University, to modify the process by which sulfur is removed from crude oil – a vital step in turning oil into usable fuel. The goal is to synthesize catalysts to make a refining process that's fit to handle the impurities of North American oil sources while reducing harmful emissions to meet Environmental Protection Agency standards.

"Our challenge is twofold: Reducing the emissions of sulfur and nitrogen oxides from burning fuels, and doing so with oil that contains significantly more sulfur impurities," Brock said. "The key to addressing this challenge is synthesizing new catalysts that facilitate a more rigorous and efficient refining process for sulfur removal. The resultant ultra-low sulfur fuels in turn enable the use of advanced emissions control systems that reduce the formation of nitrogen oxides."

The traditional refining process uses sulfide catalysts, which have been known to become "deactivated" over time, removing less and less sulfur from the crude oil until they stop completely. Brock and Bussell will test the potential of nickel phosphides as an alternative catalyst. "What we'd like to have is a catalyst with a greater efficiency and a longer lifetime," Brock said. "Metal phosphides are more resistant than conventional sulfides to losing their functionality. They also seem to have a higher rate of activity and can remove more sulfur overall."

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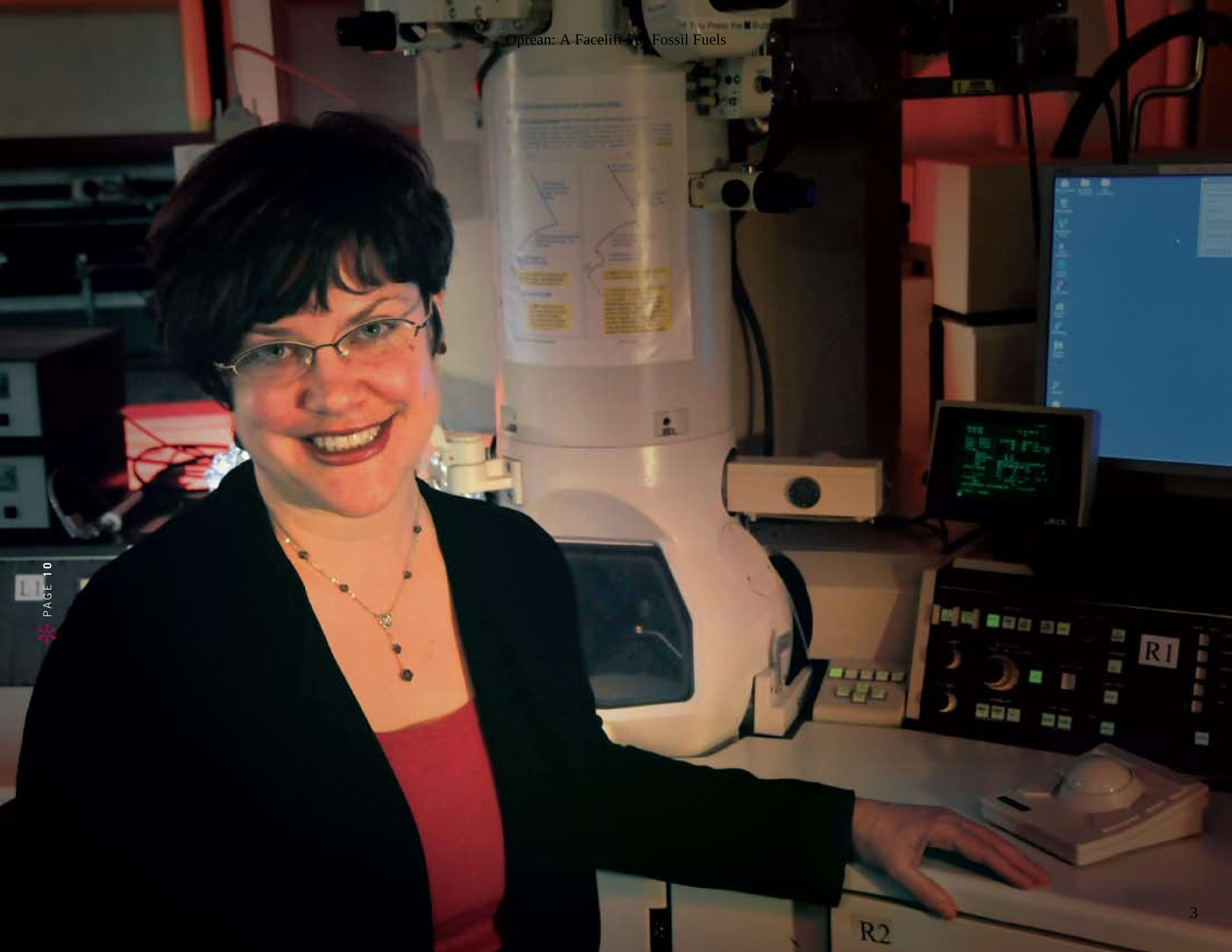
For the study, Brock's lab has taken the role of synthesizing the nickel phosphide nanoparticle catalysts of different sizes and shapes, with Bussell's lab then performing catalytic studies. The studies will determine the factors, such as particle surface area and crystal face reactivity, which are important for achieving optimal sulfur removal.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A facelift for fossil fuel continued

Oil security

Metal phosphides' high catalyst potential may prove useful for developing a refining process rigorous enough and economically viable for use on North American crude oil sources, which have greater impurities than Middle Eastern sources and are more difficult to refine. "Sulfur is one of several impurities that are more abundant in North American oil sources than that of places like Saudi Arabia," Brock said. "If metal phosphide catalysts are shown to remove a larger amount of sulfur from a more impure source, we would be significantly closer to independence from foreign oil."

Cleaner air

Brock's research also aims to lower the amount of sulfur dioxide and nitrogen dioxide that gasoline releases into the atmosphere. Sulfur dioxide contributes to respiratory illness, particularly in children and the elderly, and aggravates existing heart and lung diseases. It also is a primary contributor to the formation of acid rain, which damages trees, crops, historic buildings and monuments; and makes soils, lakes and streams acidic. Nitrogen dioxide contributes to the formation of ground-level ozone and fine-particle air pollution and is linked with a number of adverse effects on the respiratory system.

The EPA has set diesel fuel standards that reduce allowable sulfur emissions from 500 parts per million to 15 parts per million by 2010, and nitrogen oxide emissions from engines from 4 to 0.2 grams per brake horsepower hour. These standards are expected to become even more rigorous in the future. Brock's research could provide essential information to enable these standards to be achieved. "If we can determine which aspects of these nanoparticles influence how active they are as catalysts, then we may be able to use them in a refining process that meets the EPA's goals," she said.

The benefits of alternative catalysts are not limited to cars that burn cleaner. Fuel cells that run on hydrogen could also benefit from an improved refining system, since a common method of obtaining hydrogen is from hydrocarbon fuels – a reaction requiring the same sulfur-removing process. The catalysts could also lead to lower emissions from traditional power plants.

Near-future solutions

As advancing technologies such as solar and hydrogen power are making headway as viable forms of energy, Brock sees the potential of her research as a more immediate improvement to the country's most pressing energy issues. "I think it's understood that we're going to continue to need fossil fuels for transportation, at least in the short term," Brock said. "Because of this, it's very important that we develop solutions to problems of the current system – meeting environmental regulations and addressing the energy security issues – while other alternatives are being developed."

About Dr. Stephanie Brock:
Dr. Brock received a B.S. in chemistry from the University of Washington, a Ph.D. in chemistry from University of California, Davis and was a postdoctoral associate at the University of Connecticut. She joined Wayne State University in 1999.

To learn more, visit:
http://chem.wayne.edu/brockgroup