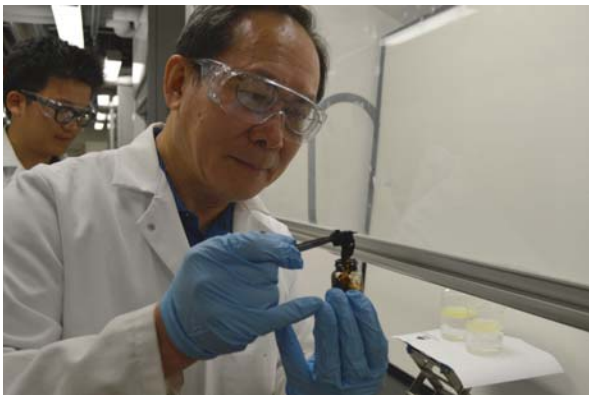
PennState



Michael Chung, professor of materials science at Penn State, holds a solid chunk of oil that is able to be reused. Chung and his team developed a material called PetroGel that completely absorbs spilled oil and transforms it into a usable product.

Image: Penn State

Diapers, absorbents and a material that makes oil spills reusable

by Liam Jackson
August 25, 2015

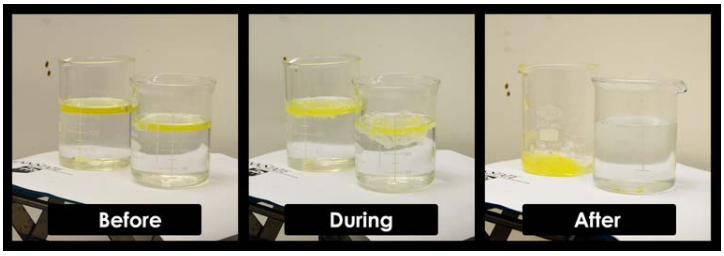
In 1989, Mike Chung became interested in how to clean up massive oil spills. As a researcher with Exxon Corporation, Chung participated in discussions about how to clean up the hundreds of thousands of barrels of oil spilled off the coast of Alaska by the Exxon Valdez. Unfortunately, every solution had drawbacks.

"One common approach to clean an oil spill is to use containment booms to physically corral the oil in one location, then either collect it with a skimmer, or burn it in a controlled manner. Another approach is to use dispersants that mix oil and water, much like soap we use to wash oil off our hands. There are problems with both of these approaches: the first doesn't collect all the oil, and the second leaves pollutants in the environment, potentially hurting wildlife and seafood supply," says Chung.

Chung joined Penn State's Department of Materials Science and Engineering later that same year, where he focused his research on synthesizing plastics and other materials with unique chemical and physical properties. Then in 2012, the largest oil spill in history occurred after the Deepwater Horizon oil rig exploded in the Gulf Coast. Chung decided to devote some of his research to oil spill cleanup solutions under the sponsorship of the Ben Franklin Foundation.

“More than two decades had passed, and we were still using the same solutions to address large-scale oil spills. But I knew there had to be a material that could better address the problem. I remember back in the 1980s, wondering if there could be some way to pick up the oil from the surface selectively,” he says.

Chung and his research team began scouring the world of materials to find something that would be more effective than dispersants and containment booms. One thing they looked at was disposable diapers, which contain a material that behaves in a way that they thought might work well for oil spills.



PetroGel completely absorbs all oil it comes into contact with. Pictured here are the before, during, and after stages of PetroGel as it is added to a container of water mixed with diesel gas. The result is clean water and a solid oil material that can easily be removed from the water.

Image: Penn State

Inspired by a Material in Diapers

A hydrogel is a kind of polymer that can absorb large quantities of water. It’s what turns squishy as a diaper gets full. It works by absorbing water upon contact and swelling in size.

“That mechanism of swelling in size while absorbing water really interested us. But we were seeking a material that would do this with oil instead of water, and one that would not interact with water. Additionally, we were looking for a material that would remain a solid rather than disintegrating after use, and something that could be sprayed from an airplane on top of the water, because you can’t always navigate by land or air to where oil spills happen. To effectively recover oil and reduce the environmental impact, we needed a material that could be used quickly, to prevent oil from evaporating, emulsifying or spreading in other ways,” he says.

They knew of materials, such as paper towels, that can absorb oil and water, but those wouldn’t be effective in a sea or ocean. They also were aware of materials that can absorb oil and not water, but none were very effective for crude oils. After an exhaustive search through known materials produced no solution, Chung and his team ended up creating a new material in their lab that met all their needs.

Their creation is PetroGel, which is now trademarked and patented by Penn State. It is a plastic that, just like hydrogel in diapers, starts off as a small, barely visible particle. Then, as it touches

oil molecules, it grows in size, absorbs the oil molecule and doesn't disintegrate—instead, it congeals into a chunk.

"In 10 minutes, PetroGel can absorb 10 times its volume in crude oil. After 24 hours, it absorbs 40 times its volume in crude oil, and it doesn't absorb water," says Chung.

From Spilled Oil to Usable Oil

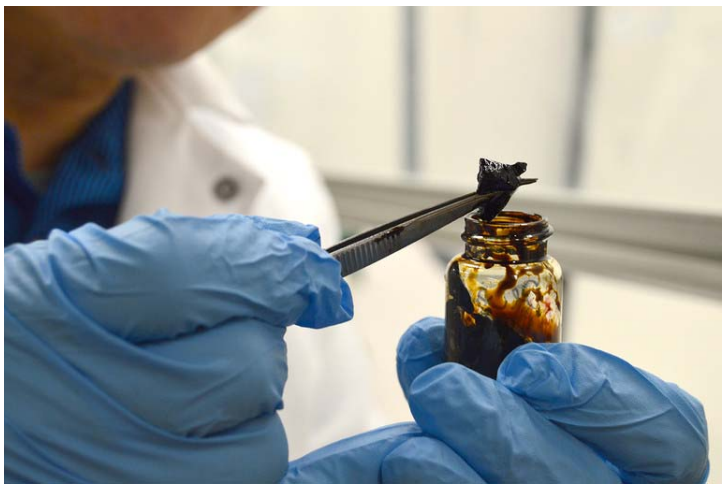
PetroGel is a kind of plastic, and plastics are derived from oil. Oil is less dense than water, which makes it float. Because PetroGel is also oil based and less dense than water, after PetroGel absorbs oil molecules it floats on the water's surface, easy to see and pick up.

Its oil-based nature provides another useful benefit, says Chung.

"After we use PetroGel, the resulting material is a pure hydrocarbon, and it can be transformed completely back to a usable form of oil," says Chung.

This benefit prevents secondary pollution.

"The dispersants that were used in the Deepwater Horizon oil spills left a certain amount of chemicals in the environment. PetroGel has the potential to collect all the oil molecules in one spot and transform them into a product that can be processed back into usable oil. This not only helps with cleanup, but it can be cost effective for the companies cleaning up spills," he says.



Close-up of PetroGel after it has absorbed a petroleum-based oil.
Image: Penn State

Chung has tested PetroGel on a small scale in his laboratory and has seen positive results. Starting this winter, he will begin a large-scale performance test in partnership with the U. S. Department of Interior's Bureau of Safety and Environmental Enforcement. This will test whether 250 pounds of PetroGel can absorb 10,000 pounds of Alaskan North Slope crude oil in Arctic sea environments—accounting for wave size, water temperature and ice. If this proves successful, Chung will work with industry partners to mass produce PetroGel.

Chung and his team also are brainstorming alternate uses for PetroGel. Hydrogels, in addition to being used in diapers, are responsible for the slow-release mechanism of medicine and they are used to treat burns. Chung envisions many uses for PetroGel: to prevent oil leaks on train cars and pipelines, to help refine and store natural gas and with shale gas and oil operations.

“However we can contribute to clean up and prevent pollution to the shoreline, save wildlife and ensure safe seafood supply is good. I believe that our technology will go beyond this original use,” says Chung.

This article originally appeared in the Centre Daily Times.

CONTACTS:

Patricia L. Craig, plc103@psu.edu
Work Phone: 814-863-4663
http://www.ems.psu.edu

Marketing and communications, Earth and Mineral Sciences

Last Updated August 25, 2015