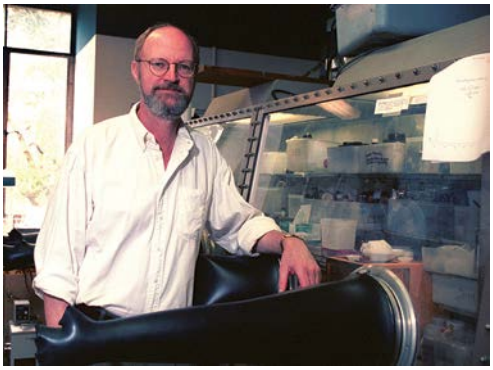

**ABOUT THE IMAGES**

*Drilling rig used for oil exploration and recovery. It lowers drill strings and specialized oil recovery pipe as much as 7 miles down to the seabed in the Gulf of Mexico.*
(ISTOCK.COM /MIKEUK)

*BES-supported research for individual university-based investigators, including Robert Grubbs at Caltech, played a significant role in the development of powerful catalysts that have transformed the chemical industry.*
(CALTECH)

# *TRANSFORMING* THE CHEMICAL INDUSTRY

**There are huge reservoirs of oil in the deep waters of the Gulf of Mexico. A major oil company is now retrieving that oil safely, despite huge challenges—oil leaves the seabed at boiling hot temperatures, through 7,000 feet of steel pipe exposed to corrosive saltwater at temperatures near freezing. An extra margin of safety comes from a specialized plastic coating on the pipe that both insulates and protects the pipe: it can cope with oil as hot as 390°. The special plastic is made from chains of carbon-based molecules (called polymers) that do not occur in nature. Rather they are the result of a powerful chemical process developed over decades of research by two university scientists—research supported by the Basic Energy Sciences (BES) office of DOE and other federal agencies—for which they were both awarded a Nobel Prize. That process expanded the chemical industry's toolset, enabling many new products as well as more efficient production processes.**

## The Breakthrough

***Discovery of specialized organic molecules containing a metal atom that can drive—or "catalyze"—a chemical process to synthesize a wide range of novel plastics and other materials.***

- It required two decades of persistent fundamental research—mostly in university laboratories, supported by BES and other federal agencies—to devise practical catalysts.
- It required another two decades of applied research to refine those catalysts for commercially important applications.

## The Impact

***A powerful toolkit that enables the chemical industry to create a wide range of new organic molecules, resulting in applications from specialized plastics to pharmaceuticals, pest control chemicals, and perfumes.***

- The ability to create novel materials, such as plastics to coat oil recovery pipes for use in the Gulf of Mexico, a drug to treat hepatitis B, and a material used to create tiny electronic circuit patterns in the manufacture of semiconductor chips.
- Biorefineries that use palm oil or other natural products as feedstocks to convert into chemicals and fuels.
- More efficient synthesis of a wide range of chemicals, and cleaner and more environmentally friendly production processes.

## The Takeaway

***Patient support of fundamental research by individual investigators over decades—BES, for example, has been supporting research on the synthesis of polymers for more than 30 years—was critical to the breakthrough and the subsequent industrial transformation.***

*Adapted from chapter 11 of A Remarkable Return on Investment in Fundamental Research, U.S. DOE, June 2018.*
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