'Impossible' Molecular Chain Reaction on Metal is Demonstrated

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People said it couldn't be done, but researchers from the University of Pittsburgh and the U.S. Department of Energy National Energy Technology Laboratory (NETL) in Pittsburgh demonstrated a molecular chain reaction on a metal surface, a nanoscale process with sizable potential in areas from nanotechnology to developing information storage technology.

The researchers report in the Dec. 12 edition of *Science* that a single electron caused a self-perpetuating chain reaction that rearranged the bonds in 10 consecutive molecules positioned on a gold surface. As each molecule's original bond was broken by the reaction, the molecule rearranged itself to form a new molecule.

Study coauthor Kenneth Jordan, a Distinguished Professor of Chemistry in Pitt's School of Arts and Sciences and codirector of the University's Center for Simulation and Modeling, said that the ability to initiate molecular chain reactions and self-assembly has potential applications in information storage and in nanolithography, a process used in producing microchips and circuit boards.

Because the demonstrated reaction involved several molecules on a surface, it reframes researchers' understanding of surface-based chain reactions. “The conventional wisdom held that a surface reaction would fizzle soon after the electron was introduced,” Jordan said. “Our work, however, shows that reactions on metal surfaces can be sustained over long distances.”

Jordan and his colleagues worked with dimethyldisulfide molecules-two CH(3) methyl groups bonded by two adjoining sulfur atoms. The added electron split the bond between the sulfur atoms of one molecule, creating a highly reactive free radical that attacked the sulfur-sulfur bond of the neighboring molecule. The radical split the bond, resulting in a new molecule and a new radical that proceeded to the sulfur-sulfur bond of the next molecule. The process repeated itself through a series of molecules.

Jordan conducted the research with Peter Maksymovych, who received his PhD degree in physical chemistry from Pitt in 2007 and is now at the U.S. Department of Energy Center for Nanophase Materials Sciences; Dan C. Sorescu of NETL; and John T. Yates Jr., a former Pitt Mellon Professor of Chemistry and now at the University of Virginia. Maksymovych and Yates carried out the experiments and Jordan and Sorescu performed the supporting theoretical calculations.

Provided by University of Pittsburgh

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