Scientists Discover That Gold Is A ‘Reactive Metal’ by Accidentally Creating a New Material in the Lab   Earth.com (12/24/2025)

In a high-pressure lab experiment, scientists accidentally created a new compound called gold hydride. This particular hydride formed when thin gold foil met dense hydrogen at pressures hundreds of thousands of times Earth's atmosphere and blazing temperatures.

The discovery challenges gold's reputation as a nearly inert metal and shows how extreme conditions can push familiar materials into unfamiliar forms. By creating gold hydride in the lab, researchers opened a way to study dense hydrogen like that inside giant planets and fusing stars.

Creating gold hydride

The work was led by Mungo Frost, a staff scientist at Stanford Linear Accelerator Center (SLAC) whose research probes materials under extreme pressures and temperatures. Gold is usually chosen for experiments like this because it barely reacts, serving as a passive X ray absorber that heats surrounding material. Gold was expected to remain inert during the experiment, since it is normally chemically unreactive and is routinely used as an X-ray absorber for that reason. That accidental reaction produced the first confirmed solid compound made solely of gold and hydrogen atoms in any laboratory experiment.

Lab built to study diamonds

The experiment was originally designed to clock how long simple hydrocarbons take to turn into diamond under crushing pressure and searing heat. Researchers squeezed tiny drops of hydrocarbon between the tips of a diamond anvil cell, a device that traps samples at immense static pressures. Laser heating inside such cells lets scientists study materials at extreme pressures, as shown in a recent review of diamond anvil work.

At the European XFEL in Germany, X-ray pulses hit a thin gold foil in the sample, which then heated the surrounding hydrocarbons. The team cranked the pressure until it rivaled Earth's lower mantle, then blasted the sample with trains of X-ray pulses.

Under those conditions, the study reports gold hydride forming at temperatures above 3,500 degrees Fahrenheit and at pressures far beyond Earth's mantle. X-ray scattering patterns confirmed that carbon atoms snapped into the tidy lattice of diamond, matching what the researchers expected from earlier work. Signals in the data revealed hydrogen atoms entering the gold lattice, forming gold hydride that altered how the metal scattered X-rays.

Gold hydride and planet formation

Under pressure and heat, hydrogen became superionic, a state where atoms move like a liquid inside a solid, making the gold hydride conductive. Hydrogen usually barely scatters X-rays, so the team watched changes in the gold lattice to deduce how the light atoms were moving. Simulations and measurements indicate that hydrogen diffuses rapidly through the hexagonal gold lattice at high temperature but separates when the sample cools. Interior models of Jupiter suggest a shell of metallic hydrogen surrounding a dense core, with pressures beyond anything on Earth's surface. In those environments, hydrogen is compressed so tightly that it behaves more like a dense, electrically conducting fluid than a simple gas.

Recent research has shown that superionic states in silica water and silica hydrogen mixtures could help explain magnetic fields in giant planets. Gold hydride offers a controlled environment where dense hydrogen's structure and motion can be measured, giving theorists a clearer target for planetary calculations.

New lens on fusion research

Stars like the Sun shine because gravity squeezes hydrogen until nuclei fuse, and fusion researchers try to recreate conditions in experiments on Earth. Accurate models of dense hydrogen, hydrogen compressed to extraordinary pressures and densities, are vital for understanding fusion fuel behavior. Simulations indicate that even small uncertainties in hydrogen's behavior at high-density can significantly change fusion predictions. By pinning how hydrogen moves through gold at given pressures and temperatures, the measurements give fusion modelers a benchmark to test their calculations.

Redefining "unreactive metals"

In everyday chemistry, gold is grouped with the noble metals that rarely form compounds, which is why jewelry stays bright for decades. In these experiments, gold formed a hydride that held more hydrogen as pressure climbed, yet separated into plain gold again when conditions eased. The findings indicate that extreme pressure and heat can enable forms of chemistry that do not occur under normal conditions. High pressure work has shown unreactive elements like xenon can form compounds, so gold hydride underscores how chemistry changes when matter is squeezed.

High tech machines

The experiments relied on the European XFEL, a powerful X-ray laser facility that delivers thousands of pulses each second to targets. Those pulses deposit energy in the gold foil, allowing scientists to heat the sample rapidly while the diamond-anvil cell maintains the pressure. High-energy-density science, the study of matter under extreme pressures and temperatures, uses intense X-ray lasers together with diamond anvil cells. As these tools improve, from tougher diamond anvils to brighter X-ray sources, researchers can probe states of matter once considered purely theoretical.

Gold hydrides and other exotic phases

Gold hydride joins a catalog of exotic phases, including superionic water and silica compounds, that appear only when atoms are squeezed and heated. Many of these phases vanish once pressure or temperature drops, yet their existence helps explain how planets move heat and generate magnetic fields. Because hydrides of other metals already show properties like superconductivity, understanding gold hydride could one day help design new electronic materials. Gold hydride's appearance under stress shows that even familiar elements in lab samples can behave unexpectedly when scientists push conditions beyond normal experience.

Lessons from gold hydride

The simulation framework that captured superionic hydrogen in gold can predict how other elements behave when infused with hydrogen at different pressures and temperatures. Future experiments can swap gold for other metals or mixtures that resemble planetary materials more closely, letting researchers test whether strange hydrides emerge. Each compound uncovered at such extremes expands the periodic table of high-pressure phases and clarifies how ordinary elements behave when pushed hard.

Some directions and questions for you to ponder:

1. Circle any word that you didn't know and/or had to look up to understand this article.
2. What two organizations were mentioned in this article?

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3. Where would you find, in nature, the conditions to from Gold Hydride?

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4. What was the intended purpose of the experiment that led to the formation of the Gold Hydride?

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5. What can the results from this experiment be used to do/model? ______________________

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