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Purpose of Research

The expectation for a hydrogen society has been on the rise recently. Hydrogen, as a gas, is not easy to handle and extensive research is underway on hydrogen-containing compounds (hydrogen carriers) that make it easier to store and transport hydrogen at ambient temperature and pressure. This study aims at practical applications of noble-gas hydrides (NgH_x , Ng: a noble gas, H: hydrogen, x: 2, 4, 5, 18 etc.), which our group has discovered, as a safe and inexpensive hydrogen carrier as well as a fuel with higher energy density than hydrogen gas.

Summary of Research

Synthesized noble-gas hydrides, in which hydrogen atoms are bonded with chemically inert noble gas atoms. After irradiating the ion beam of a noble gas onto a metal surface, hydrogen gas is introduced, and the surface temperature is raised to form noble-gas hydrides. Confirmed noble-gas hydrides are HeH_x , NeH_x , ArH_x and KrH_x (x = 2, 4, 5, 18 etc.).

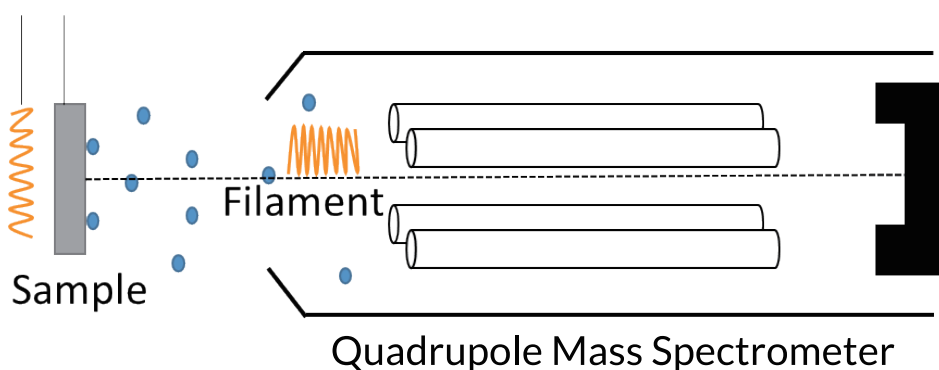


Figure: Production of noble-gas hydrides through a temperature-programmed desorption process and detection of them

Comparison with Conventional or Competitive Technologies

- Liquefiable at higher temperatures than hydrogen gas. Easier and less expensive to store and transport
- A clean and CO_2 -free fuel consisting of hydrogen and a noble gas only
- Has a higher energy density than hydrogen gas (e.g. ArH_{18} has 9 times as many hydrogen atoms as hydrogen gas)

Expected Applications

- Fuel (e.g. for automotive hydrogen internal-combustion engines and rocket engines)
- Hydrogen carrier (e.g. for fuel cells)
- Synthetic reagent (e.g. for hydrogenation reactions)

Challenges in Implementation

- Confirmed that hydrides are formed with helium, neon, argon and krypton. Their quantities are insufficient for analysis of material properties
- Experiments under low vacuum or ambient pressure in view of mass production
- Search for less expensive catalysts and new synthesis schemes
- Accomplishment of technologies for low-cost and scalable production

What We Expect from Companies

- Hope for collaborative research with companies that possess technologies in catalyst development and chemical-plant development
- Introduction to transportation (automotive and aerospace) companies applying hydrogen engines, rocket engines and fuel cells, and electric cooperatives

Points

- Easier to store and transport than hydrogen gas
- Higher energy density than hydrogen gas
- Argon hydride, a hydrogen energy medium using argon, is an inexpensive and safe gas

Future Developments

March 2022 Starting sales

■ Intellectual Property: International Patent Application No. PCT/JP2020/26472