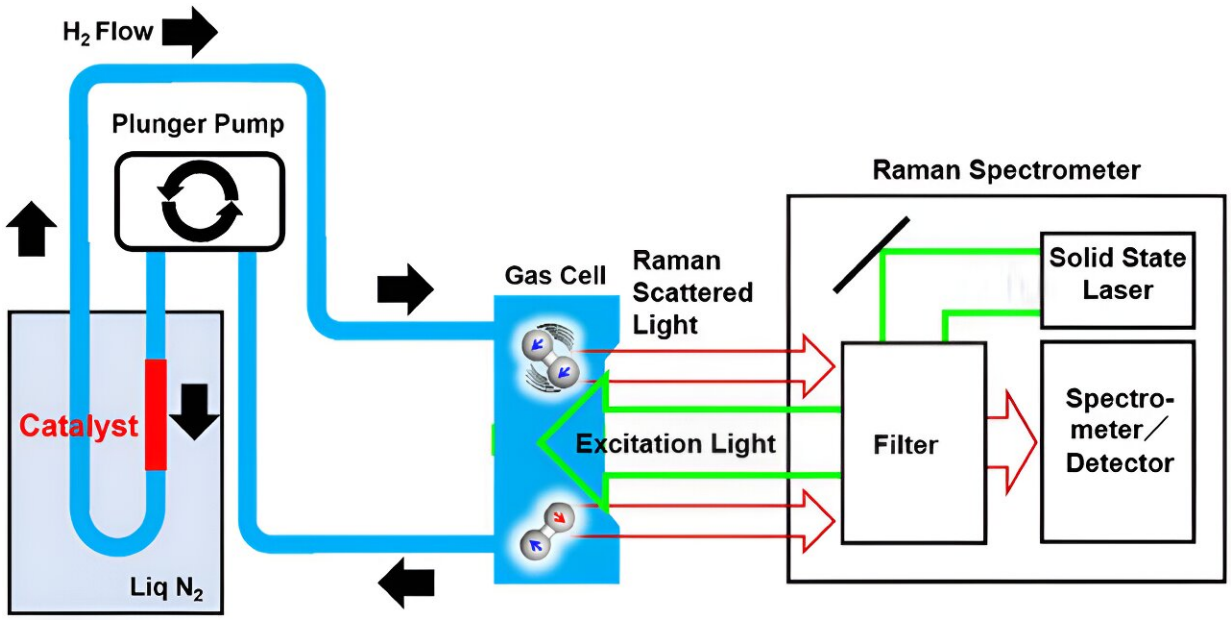
Researchers identify materials capable of catalyzing the conversion of ortho-hydrogen to para-hydrogen

March 5 2024



Experimental setup for the catalytic O/P conversion measurement. Credit: *Exploration* (2023). DOI: 10.1002/EXP.20230040

A research team consisting of NIMS and the Tokyo Institute of Technology has identified materials capable of catalyzing the conversion of ortho-hydrogen to para-hydrogen. These catalysts should be essential to the spread of mass-transportation/storage of liquid hydrogen. The research is published in the journal *Exploration*.

Hydrogen is becoming widely accepted as an alternative energy source to fossil fuels. Its liquefaction (at temperatures below -253°C under pressures higher than one atmosphere) can dramatically reduce its volume, making it suitable for transportation and storage. Hydrogen molecules (H_2)—each composed of two hydrogen atoms—exist in two isomeric forms: ortho- and para-H_2.

Under normal conditions, ortho- and para-H_2 are present in a 3:1 ratio, with ortho-H_2 slightly more energetically unstable than para-H_2. Gradually cooling H_2 to its liquefaction temperature causes all ortho-H_2 to convert to para-H_2, producing stable liquid H_2.

Rapid cooling of H_2 under high pressure—needed for liquefaction—delays the ortho-to-para conversion during the cooling process, leaving considerable amounts of ortho-H_2 in the liquid H_2 produced. The residual ortho-H_2 molecules continue to isomerize to para-H_2 during the storage, triggering partial vaporization of the liquid H_2 and resulting in significant loss of H_2 and energy.

The choice of proper catalysts prior to the liquefaction process can solve this problem because of accelerated ortho-to-para conversion. However, existing catalysts were incapable of adequately accelerating conversion and it was therefore desirable to develop more effective ones.

This research team evaluated the ability of more than 170 solid materials—including metals and ionic crystals—to catalyze ortho-to-para conversion. The team found that manganese oxide (Mn_3O_4) and cobalt oxide (CoO) exhibited significantly higher catalytic performance than conventional iron oxide-based catalysts. In addition, the team identified major factors influencing the catalytic activities of these materials in accelerating ortho-to-para conversion.

Hydrogen liquefaction is crucial for long-distance hydrogen

transportation by sea from major hydrogen producers/exporters (in particular, Australia and the Middle East) to hydrogen importers, such as Japan.

The catalyst design guidelines and high-performance catalysts developed in this research project are expected to greatly help Japan move forward with its plan to put the hydrogen economy concept into practice.

More information: Hideki Abe et al, Exploration of heterogeneous catalyst for molecular hydrogen ortho-para conversion, *Exploration* (2023). DOI: 10.1002/EXP.20230040

Provided by National Institute for Materials Science

Citation: Researchers identify materials capable of catalyzing the conversion of ortho-hydrogen to para-hydrogen (2024, March 5) retrieved 29 April 2024 from https://phys.org/news/2024-03-materials-capable-catalyzing-conversion-ortho.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.