Hydrogen Storage and Transport: State-of-art and Future

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Summary
Fuel cell vehicle that uses hydrogen as fuel will be put on the market in 2015. Paradigm shift after the earthquake on March 11th 2011 accelerates introduction of renewable energy into our society. In addition, to reduce carbon dioxide emission hydrogen is considered efficient and reasonable priced large-scale energy carrying media.
Compressed hydrogen is used for on board hydrogen storage of fuel cell vehicle. The maximum pressure of on board tank is 70 MPa and storage pressure at refueling stations is over 80 MPa. Materials and systems have been developed but there are still rooms to be improved. They are cost and densities of hydrogen of tank and development of hydrogen compatible materials.
Liquid phase materials are easy to be handled, that is one of the major reason oil has been widespread instead of solid state fuel such as coal and firewood. Liquefied hydrogen need one third of combustion energy of hydrogen to be liquefied but it has higher energy densities than compressed gas. Therefore, liquefied hydrogen is favorable applied for large scale storage and transportation. Another form of liquid phase hydrogen is that in liquid organic hydrogen carriers (LOHC). Some pairs of organic compounds can be used for hydrogen carrier. Toluene-methylcyclehexane is the most common LOHC.
Hydrogen storage materials are usually in solid state. The distance between hydrogen atoms in solid state hydrogen storage materials is shortest among any of other hydrogen storage media. However, weight hydrogen density is an issue.
The scale of hydrogen storage and transportation is widespread: from several kg for fuel cell vehicle and less to 10,000 ton for intercontinental transportation. The methods of hydrogen storage and transportation should

be selected appropriate ones for each application.

For the moment, compressed gas (gas phase storage) is used for on board applications and small scale transportation. Liquid phase media is expected to use for large scale transportation. Carrying rocket fuel for space shuttle in a form of liquefied hydrogen is one of the examples. Solid state hydrogen storage is appropriate small to medium scale hydrogen storage and transportation. In a period of mass production of fuel cell vehicle, solid state hydrogen storage is expected to use for on board hydrogen storage.

In general, to store or to release, sometimes both energy is needed. Energy efficiency and availability of energy to store/release hydrogen should be considered for hydrogen storage media.

To store gaseous hydrogen in a compact form safely and efficiently is a key to realize the hydrogen economy. Wide range of research from fundamentals to system development is really required.