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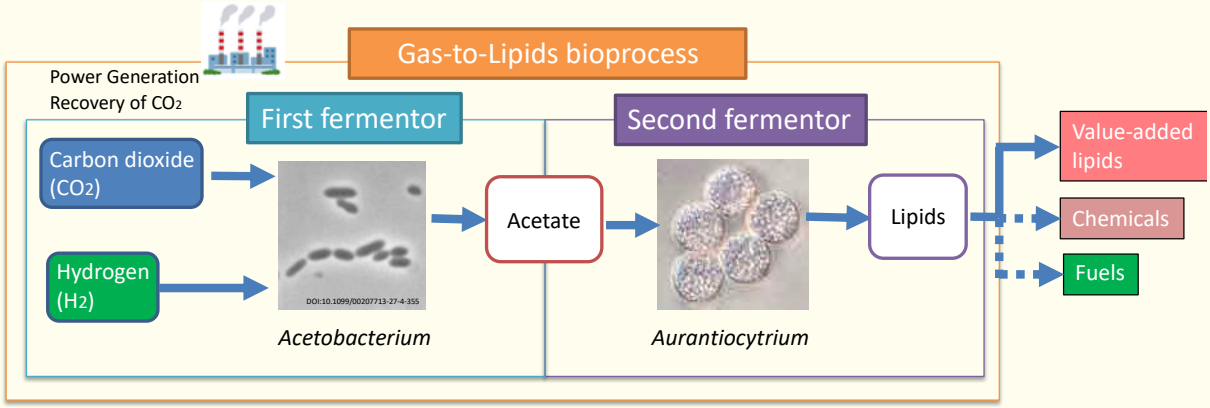
Activities of the Core

Oct. 5, 2020	The 88th Hiroshima University Biomass Evening Seminar (co-organization).
Oct. 16, 2020	The 50th HU-ACE Steering Committee Meeting.
Oct. 17-18, 2020	Prof. Ichikawa provided a lecture as an "interview class" at the Open University of Japan.
Oct. 24, 2020	The 6th Public Symposium "Sustainable Society-Satoyama, Energy and Region"(co-organization).

NEDO project has been accepted.

Coal and oil-fired power generation accounts for more than 40% of Japan's energy and power generation supply but CO_2 emitted accounts for most of the greenhouse gases to be reduced and therefore the establishment of recycling technology is urgent. The "Development of Gas-to-Lipids Bioprocess" proposed by the members of this center (Aki and Nakashimada) has been adopted in "Development of Technologies for Next-Generation Thermal Power Generation" by NEDO. In this project, we will establish a new bioprocess that combines multiple microorganisms cultivated at high speed and density in the dark to generate high-value-added lipids and raw material for chemical products (Lipids) from CO_2 (Gas) for its recycling.



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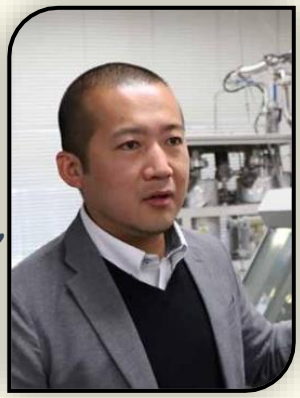
Research Topics

Utilization of functional property of alkali metal — H_2 production and NH_3 synthesis —



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Research fields: Material science, Material / Energy conversion
Keywords: H_2 storage, H_2 production, Nitride synthesis

Abstract

Background

To suppress CO_2 emission by using fossil fuels and overcome energy issues in future, enhancement of natural energy utilization is required. Various conversion techniques, which are production of H_2 as energy media and energy carrier such as NH_3 with high energy density, should be developed to establish energy system based on fluctuated and localized natural energy.

Methods

We focus on functional properties of alkali metals such as high reactivity and low melting point and propose innovative material conversion techniques by controlling the above functions. Especially, thermochemical hydrogen production technique via water splitting operated at 500-600 °C, which is lower than that of conventional ones (900-1500 °C), and small-scale / distributed type of ammonia (NH_3) synthesis systems are experimentally studied.

Results

Hydrogen production techniques via water splitting by redox reactions of sodium (Na) and heat energy below 600 °C are proposed (Fig. 1), and the reaction properties are investigated. Generally, more than 1000 °C is required to decompose oxides due to the thermodynamic stability. In the case of Na with low melting point 98 °C, it is expected that reaction temperature can be decreased by enhancing entropy change (controlling thermodynamic equilibrium) using phase transitions such as gasification and solidification. In fact, it is experimentally indicated that the hydrogen production via Na-redox cycle proceeds below 600 °C by using the above thermodynamic control.

NH_3 synthesis technique based on the functional properties such as high dissociation feature and diffusion rate of Li are proposed, and the reaction properties are experimentally investigated. As a result, it is clarified that NH_3 can be produced at ambient pressure by 3 steps reactions using Li alloys.

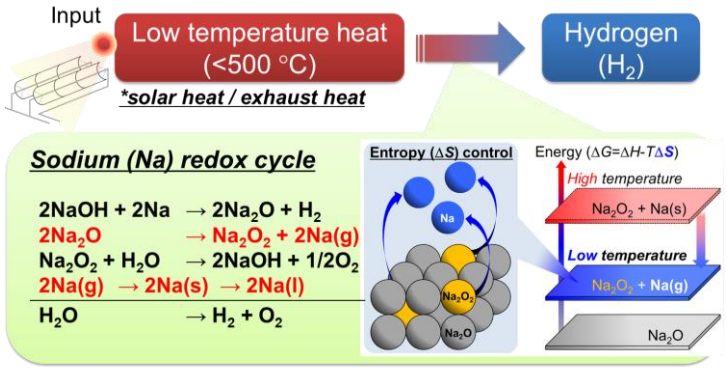

Fig.1 Low-temperature thermochemical H_2 production by Na redox cycle

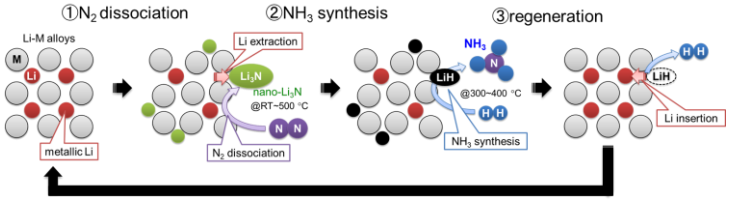

Fig. 2 Pseudo catalytic NH_3 synthesis process by Li alloy

References

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[2] Yamaguchi, T.; Shinzato, K.; Yamamoto, K.; Wang, Y.; Nakagawa, Y.; Isobe, S.; Ichikawa, T.; Miyaoka, H.*; Ichikawa, T.: Pseudo catalytic ammonia synthesis by lithium–tin alloy. *Int. J. Hydrogen Energy*. **45**, 6806 (2020).