Advanced Core for Energetics, Hiroshima University Vol. 41

HU-ACE NEWS LETTER

Advanced Core for Energetics, Hiroshima University

Vol. 41
2020.5

Activities of the Core

May.21,2020 The 45th HU-ACE Steering Committee Meeting

Research toward realization of all-solid-state battery free from rare metal acquired Grant-in-Aid for Scientific Research <KAKENHI>

Kyoto Protocol, adopted in COP3, triggered to make the word “global warming” popular for us. In those days, the word “environment” was used in many laboratories. In order to attain the carbon dioxide reduction target, it is necessary to level renewable electricity and high-performance batteries are essential. Batteries using rare metals result in a political card of countries with resources, and problems remain for stable supply. Associate Professor Shuhei Inoue, who is a member of HU-ACE, focuses on a novel battery that does not use rare metals. In a previous study , it was reported that tin-zinc oxide worked as a battery. However, even the mechanism has not been clarified and basic research is still needed. Initially, this phenomenon was considered to occur in the oxide film itself, but Dr. Inoue found that it was a redox reaction at the interface using magunesium-tin oxide film. He also found that the cause of the efficiency deterioration is caused by cracking in the film caused by the UV treatment. This research theme was accepted for JSPS funding this April.

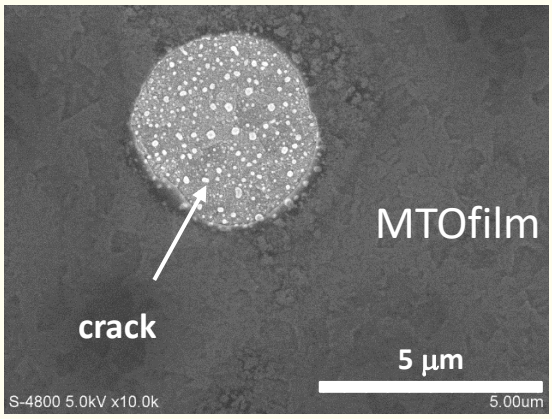

Fig. 1 Surface morphology of magnesium-tin oxide (MTO) film

Issued by Advanced Core for Energetics, Hiroshima University
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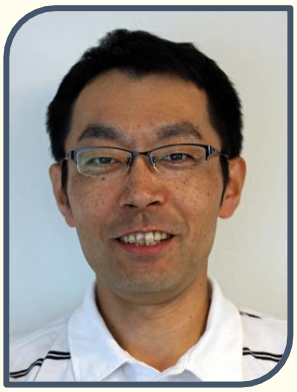
Research Topics

Biocatalyst to achieve high-yield conversion - Psychrophile-based simple biocatalyst



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Research fields: Biochemical engineering, Metabolic engineering
Keywords: Enzyme, Biocatalysis, Psychrophile, Itaconic acid

Abstract

Background

Itaconic acid is a valuable building block chemical for polymers such as latex, contact lens. Its biological production by fungus has some problems in the yield and productivity. In this study, we constructed the psychrophile-based simple biocatalyst (PSCat) for efficient itaconic acid production by expressing the conversion enzymes in the psychrophilic bacteria.

Methods

Itaconic acid is produced from citric acid by two enzymes (aconitase and cis-aconitic acid decarboxylase). Mesophilic enzymes, aconitase of *E. coli* and *cis*-aconitic acid decarboxylase of fungus *Aspergillus terrus* were expressed in the psychrophilic *Shewanella* sp. Cultivated cells are treated with heat at normal temperature. Heat treatment will give some positive effects on the biocatalysis. One is the inactivation of metabolic enzymes in the host cells intercepting substrate flow for conversion reactions while the conversion enzymes remain acitive. The other effect is increase of the membrane permeability of substrate by partial disruption of the membrane with heat treatment. Therefore, we constructed the PSCat for itaconic acid production and evaluated the productivity and the reusability.

Results

The PSCat was constructed by introduction of mesophilic enzyme genes, *acnB* of *Escherichia coli* for aconitase and *cadA* of fungus *Aspergillus terrus* for *cis*-aconitic acid decarboxylase into psychrophilic bacteria (*Shewanella* sp. strains). Itaconic acid was produced with high yield (more than 90%). Furthermore, the PSCat could be reused for the production. Cell washing decreased the productivity, however, immobilization will improve the sustainability of the reactions. PSCat could be applied for the conversion containing impurities. Citric acid is produced as byproduct of Shochu fermentation by *Aspergillus* sp. It is mainly contained in Shochu distillery by-product (lees). PSCat successfully produced itaconic acid with high yield from Shochu lees containing citric acid. PSCat is expected to apply for the efficient conversion of various valuable chemicals by the combination of mesophilic enzymes for conversion pathway.

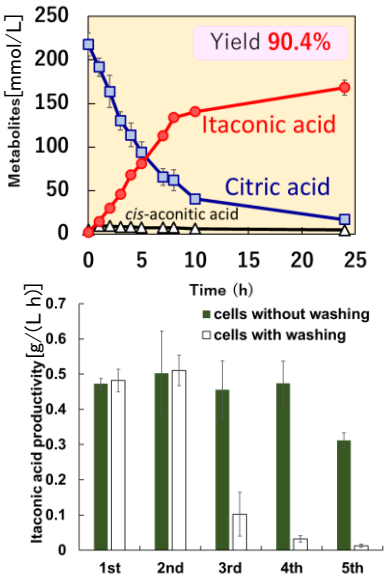

Fig.1 Itaconic acid production by PSCat; time-course (upper), recycle use (lower)

References and Patents

[1] G. Luo, M. Fujino, S. Nakano, A. Hida, T. Tajima, J. Kato: Accelerating itaconic acid production by increasing membrane permeability of whole-cell biocatalyst based on a psychrophilic bacterium *Shewanella livingstonensis* Ac10, *Journal of Biotechnology*, **312**, 56-62 (2020).
[2] Japanese Patent: Production of itaconic aced using psychrophile, Appplication number 2018-124796, Filing Date：29 June, 2019, Inventors: T. Tajima, J. Kato, G. Luo, Applicant: Hiroshima University