

# A1

## Demonstration of the integrated two stage(anaerobic & photo) fermentation process for hydrogen production

This research focuses on further optimization of fermentative H<sub>2</sub> production process using various organic wastes, which was developed through the Phase 1 and 2 of project, to promise for industrial application. Factors of the photo-fermentation using the effluent from the process of fermentative H<sub>2</sub> production will be studied to develop the sequential dual (dark anaerobic & photo fermentation) system to enhance the H<sub>2</sub> production efficiency. The conversion efficiency of glucose will be 7 mol H<sub>2</sub>/mol glucose equivalent in this dual system.

### Goal

#### two stage(anaerobic & photo) fermentation process for hydrogen production

- Efficiency of two-stage (anaerobic & photo) fermentative H<sub>2</sub> production: 7 mol H<sub>2</sub>/mol glucose equiv.
- Conversion efficiency of organic wastes(feed-stock) to hydrogen: >60%

### Objective

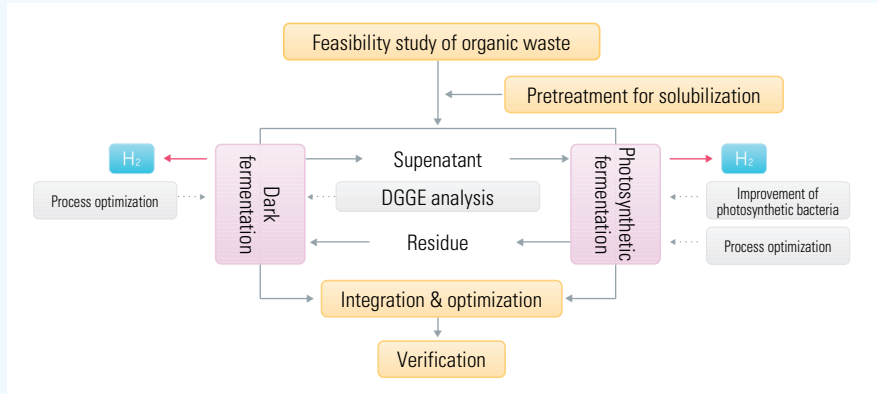
- 1st year
  - Feasibility study of various organic wastes
  - Optimization of continuous dark fermentation(glucose, other organic substances, glycerol)
  - Studies on the culture conditions of R. sphaeroides KD 131(wild/mutant) ( I )
  - Improvement of nitrogenase and hydrogenase expressions and NH<sub>4</sub><sup>+</sup>inhibition
  - Pretreatment and solubilization of various biomass
- 2nd year
  - Development of the two-stage fermentation process and photo-bioreactor design
  - Studies on the culture conditions of R. sphaeroides KD 131(wild/mutant) ( II )
  - Mass expression of hydrogenase genes and identification of salt-tolerance genes
  - Thermophillic H<sub>2</sub> production from lignocellulosic and microalgae biomass using the isolated strains ( I )
- 3rd year
  - Reactor and process design for two-stage fermentation
  - Improvement of light efficiency genes of R. sphaeroides KD 131 and DGGE analysis of fermentative reactor
  - Thermophillic H<sub>2</sub> production from lignocellulosic and microalgae biomass using the isolated strains ( II )
- 4th year
  - Demonstration and long-term operation of the integrated two stage fermentation process
  - Simultaneous mutation of R. sphaeroides KD 131 for the enhanced H<sub>2</sub> production
  - Optimization of H<sub>2</sub> production process using hyperthermophilic/thermophilic bacteria and photosynthetic bacteria



**Mi-Sun KIM**

Bioenergy Research Center,  
 Department of New & Renewable Energy Research  
 KIER  
 E-mail : bmmskim@kier.re.kr  
 Participants : KIER, Sogang Univ., Sungkyunkwan Univ.,  
 Researchers : 22 persons (National Institute 14, Univ. 8)

Strategy



Outcomes & benefits

- Integration of bio and nano technology
- Industrial application of genetically modified photosynthetic bacteria
- Application for electricity supply as a household
- Market share over 10% at treatment of organic waste
- Methane fermentation for a post-treatment

Publications (2nd stage)

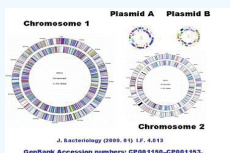
Patent		Theses							Proceedings		
domestic	foreign	domestic			foreign			total sum	domestic	foreign	sum
		SCI	Non SCI	sum	SCI	Non SCI	sum				
9/7	3/0	1	7	8	10		10	18	29	31	60

■ Publications

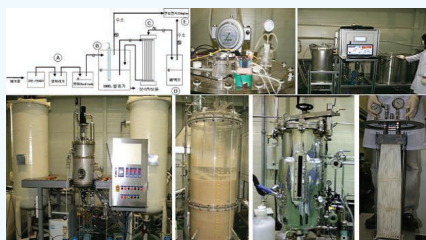
1. M. S. Kim, D. Y. Lee, "Fermentative hydrogen production from tofu-processing waste and anaerobic digester sludge using microbial consortium", *Bioresource Technology*, 2009
2. "Biological hydrogen production system equipped with membrane module for high cell density cultivation of anaerobic microorganism", *PCT-KR2008-004757*, 200



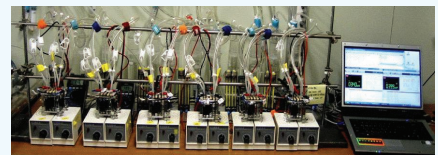
Biomimetic photochemical H<sub>2</sub> production device



*R. sphaeroides* KD 131 genome



100 L-scale membrane bioreactor system for H<sub>2</sub> production



Biomimetic H<sub>2</sub> production device