2022「中技社科技獎學金」
2022 CTCI Foundation Science and Technology Scholarship
境外生研究獎學金
Research Scholarship for International Graduate Students

Engineered *Escherichia coli* for high value chemicals by strengthening pyridoxal 5'-phosphate-dependent protein
強化大腸桿菌磷酸吡哆醛依賴性蛋白實現高值化學品生產

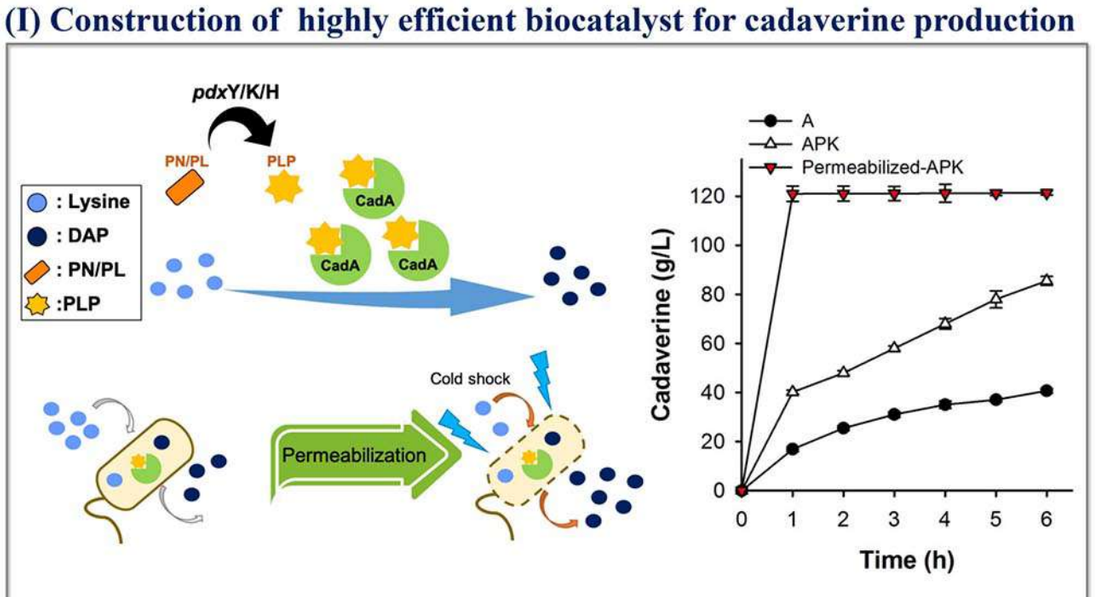
4th PhD, Chengfeng Xue, Advisor: I-Son Ng
Department of Chemical Engineering, National Cheng Kung University

Abstract

In recent years, with the advance of biotechnology and the development of a variety of genetic editing tools, more and more scientists have put into constructing green microbial cell factories to produce chemicals instead of chemical synthesis. The Green fabrication process not only helps to reduce environmental pollution but also comes to net-zero carbon dioxide emission. Nylon, also known as polyamide (PA), is the general name of thermoplastic resin containing repeated amide groups on the molecular skeleton, with excellent mechanical properties. In this study, bio nylon precursors (i.e., cadaverine and 4-aminobutyric acid) were synthesized from genetic *Escherichia coli* by strengthening pyridoxal 5 '-phosphate dependent protein. As a result, a novel antibacterial nanofiber membrane of biobased PA56 was prepared from cadaverine and applied to inhibiting *Escherichia coli* and *Pseudomonas putida*.

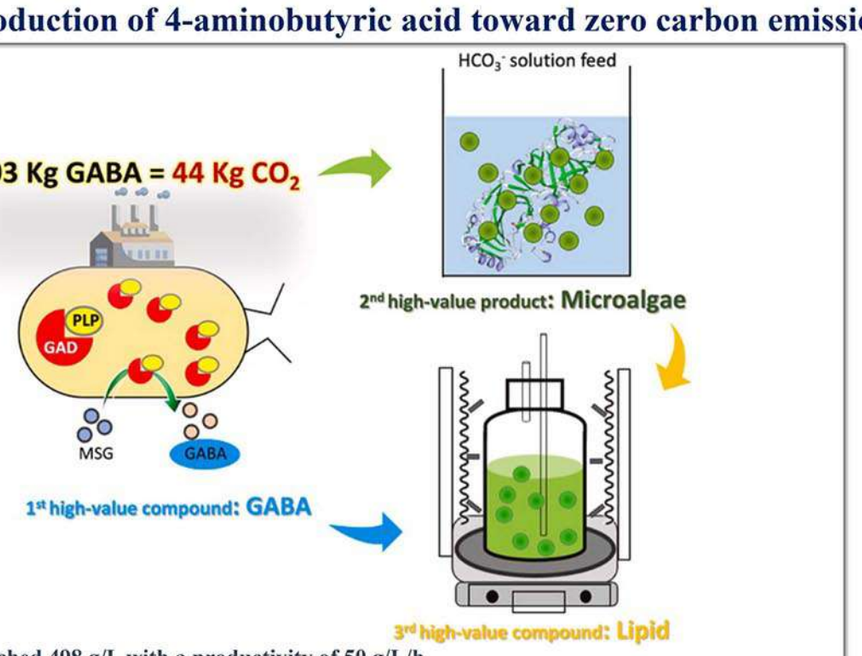
Research Focus

(I) Construction of highly efficient biocatalyst for cadaverine production



- The APK with cold treatment successfully converted 1.2 M L-lysine into cadaverine within 1 hr, and achieved a cadaverine titer, molar yield and productivity of 121 g/L, 99.2% and 121 g/L/h.

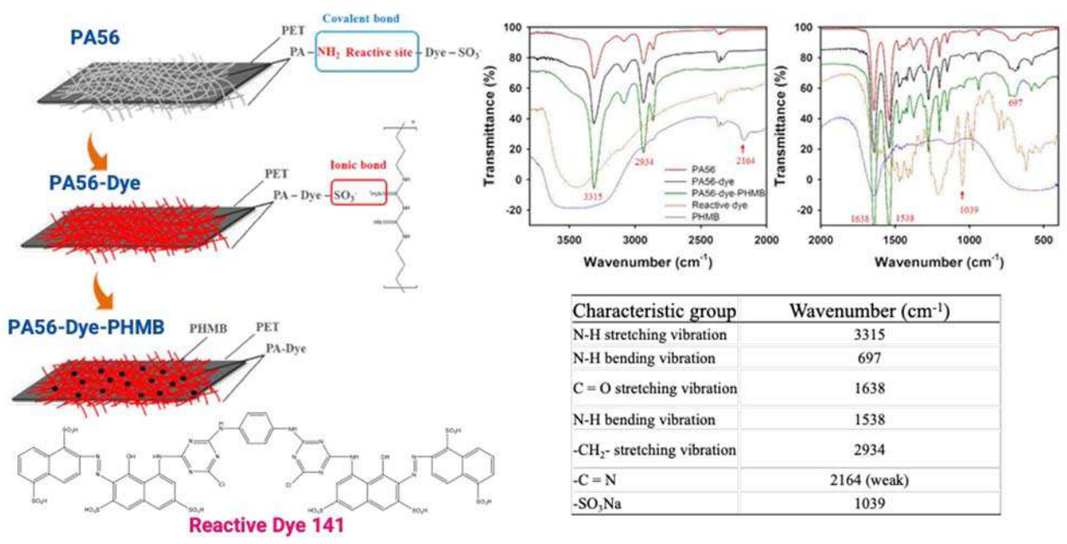
(II) Sustainable production of 4-aminobutyric acid toward zero carbon emission



- The GABA titer reached 498 g/L with a productivity of 50 g/L/h.
- Carbonic anhydrase was employed to increase carbon sequestration in microalgae system.

(III) Fabrication of bio-based polyamide 56 and antibacterial nanofiber membrane from cadaverine

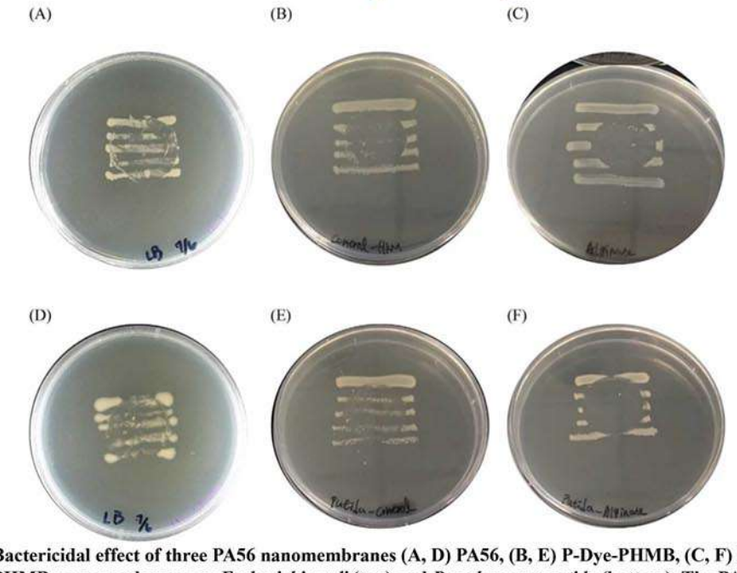
Characterization of nanofiber membranes



Characteristic group	Wavenumber (cm^{-1})
N-H stretching vibration	3315
N-H bending vibration	697
C = O stretching vibration	1638
N-H bending vibration	1538
$-CH_2-$ stretching vibration	2934
-C = N	2164 (weak)
$-SO_3Na$	1039

- The antimicrobial agent PHMB is bound to sulfite or alginate on the reactive dye on the surface of PA56 and FTIR test was performed to determine the active functional groups.

Antibacterial activity of PA-Dye-PHMB



- Bactericidal effect of three PA56 nanomembranes (A, D) PA56, (B, E) P-Dye-PHMB, (C, F) P-Alg-PHMB nanomembranes on *Escherichia coli* (top) and *Pseudomonas putida* (bottom). The PA-Dye-PHMB nanofiber was successfully applied into inhibiting *E. coli* and *P. putida*.

Selected Journal Publications

1. **Xue, C.**, Ng, I. S. (**2022**). Sustainable production of 4-aminobutyric acid (GABA) and cultivation of *Chlorella sorokiniana* and *Chlorella vulgaris* as circular economy. *Bioresource Technology*, 343, 126089.
2. **Xue, C.**, Yi, Y. C., Ng, I. S. (**2021**). Migration of glutamate decarboxylase by cold treatment on whole-cell biocatalyst triggered activity for 4-aminobutyric acid production in engineering *Escherichia coli*. *International Journal of Biological Macromolecules.*
3. **Xue, C.**, Hsu, K. M., Chiu, C. Y., Chang, Y. K., Ng, I. S. (**2021**). Fabrication of bio-based polyamide 56 and antibacterial nanofiber membrane from cadaverine. *Chemosphere*, 266, 128967.
4. **Xue, C.**, Hsu, K. M., Ting, W. W., Huang, S. F., Lin, H. Y., Li, S. F., Chang, J. S., Ng, I. S. (**2020**). Efficient biotransformation of L-lysine into cadaverine by strengthening pyridoxal 5'-phosphate-dependent proteins in *Escherichia coli* with cold shock treatment. *Biochemical Engineering Journal*, *161*, 107659.