METABIODIVEX | université PARIS-SACLAY

Journée Scientifique Biocatalyse - Biomasse

16th January 2026, Université Paris-Saclay

Recycling CO_2 into valuable resources: toward enzymatic variants catalyzing the conversion of formaldehyde to methylamine

Lucille Hervé,[1] Adrien Debard,[1] Jean-Louis Petit,[1] Anne Zaparucha,[1] Emmanuel Nicolas,[2] Carine Vergne[1]

[1]Génomique Métabolique, Genoscope, Institut François Jacob, CEA, CNRS, Univ Evry, Université Paris-Saclay, 91057 Evry, France

[2] NIMBE, CEA, CNRS, Université Paris-Saclay, CEA Paris-Saclay, CEDEX Gif-sur-Yvette 91191, France

lherve@genoscope.cns.fr

Despite the substitution of a considerable part of our energy supply with low-carbon fuels, nearly one third of industrial energy use can not be carbon-free. Developing strategies based on carbon sources independent of fossil resources is therefore essential. The circular carbon economy seeks to recover carbon from emitted CO_2 and convert it into fuels and value-added molecules. CO_2 is first reduced to C1 intermediates, which are then upgraded through functionalization.

In this context, new routes for the chain elongation and functionalisation of C1 molecules into industrially relevant compounds are urgently needed. Enzymes offer a sustainable solution, enabling such transformations under mild conditions and using low-carbon energy inputs[1]. Within the framework of PowerCO2 project (PEPR SPLEEN), we propose the enzymatic reductive amination of the C1 formaldehyde to the value-added industrial chemical methylamine.

This work focuses an enzyme family extensively investigated in our research unit through (meta)genomic mining of the biodiversity, namely the amine dehydrogenase (AmDH) family[2–3] . We will present preliminary results on the identification of an AmDH exhibiting promiscuous activity toward formaldehyde, as well as perspectives for further improvement of its activity.

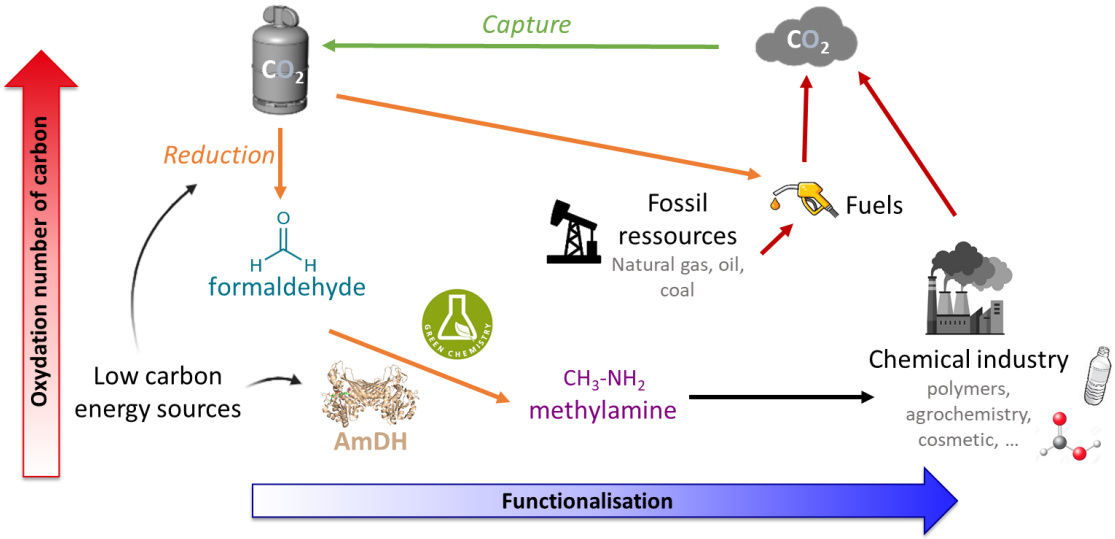

Figure 1: Enzymatic Reductive Amination of Formaldehyde into Methylamine within the Carbon Capture and Utilization Concept

References :

[1] Hauer, B. *ACS Catal.* **2020**, *10* (15), 8418–8427.

[2] Mayol, O.; Bastard, K.; Beloti, L.; Frese, A.; Turkenburg, J. P.; Petit, J.-L.; Mariage, A.; Debard, A.; Pellouin, V.; Perret, A.; de Berardinis, V.; Zaparucha, A.; Grogan, G.; Vergne-Vaxelaire, C. *Nat Catal* **2019**, *2* (4), 324–333.

[3] Elisée, E.; Ducrot, L.; Méheust, R.; Bastard, K.; Fossey-Jouenne, A.; Grogan, G.; Pelletier, E.; Petit, J.-L.; Stam, M.; de Berardinis, V.; Zaparucha, A.; Vallenet, D.; Vergne-Vaxelaire, C. *Nat Commun* **2024**, *15* (1), 4933.