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ALTERNATIVE START-UP STRATEGIES FOR THE BIOELECTROSYNTHESIS OF ACETATE

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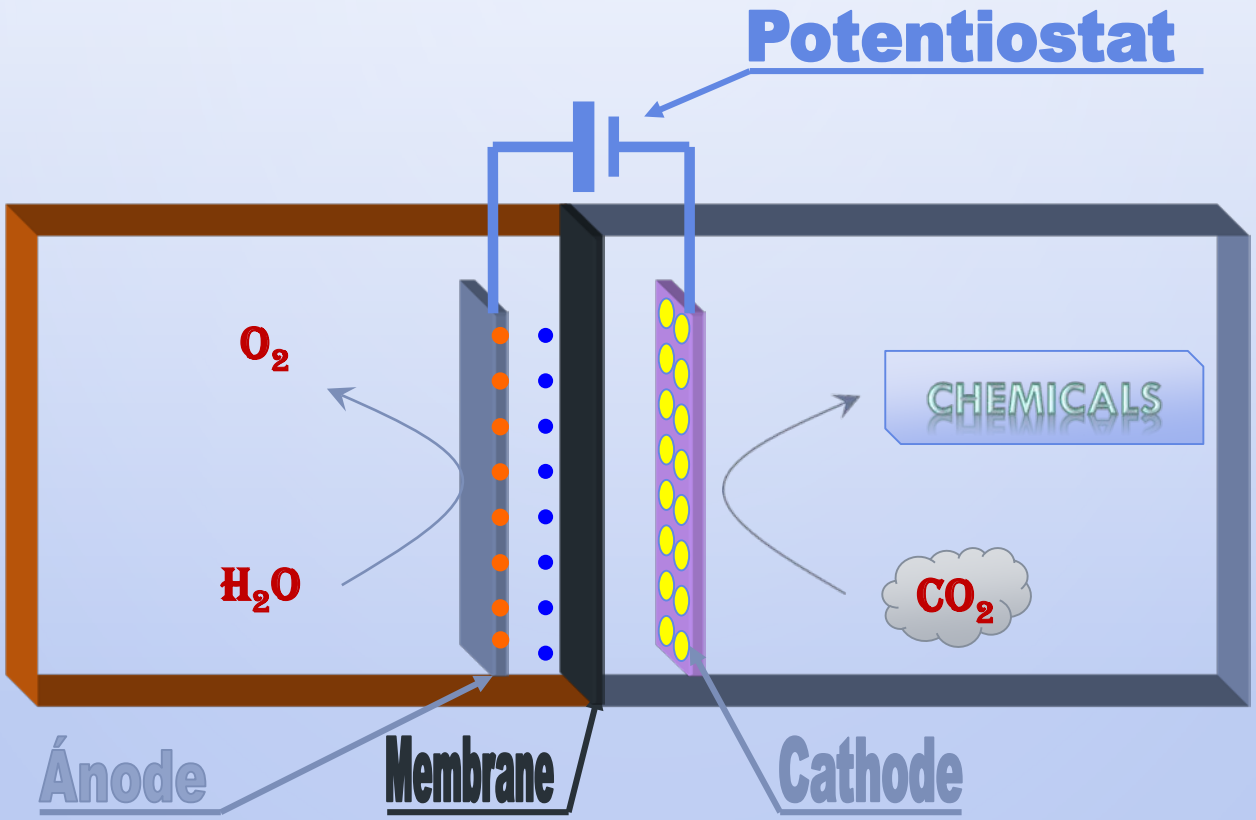
INTRODUCTION

- Carbon capture & utilisation is one of the major challenges nowadays.
- Novel ideas to generate value added chemicals from CO_2: Microbial Electrosynthesis (MES)
- CO_2 bioreduction:

  Variety of possible products (HAc, H_2…)
- Microbial community: Pure cultures or mixed cultures
- MES is a young technology: Currently in proof of concept
- Several unknown behaviours and internal processes

INTRODUCTION

How does a microbial electrosynthesis system work?



OBJECTIVES

Main objective

Evaluation of different biocathode start-up strategies

Evaluation in terms of:

Current production

Production of valuable chemicals: VFAs, H_2…

Microbial community analysis: inocula and evolution on working electrodes

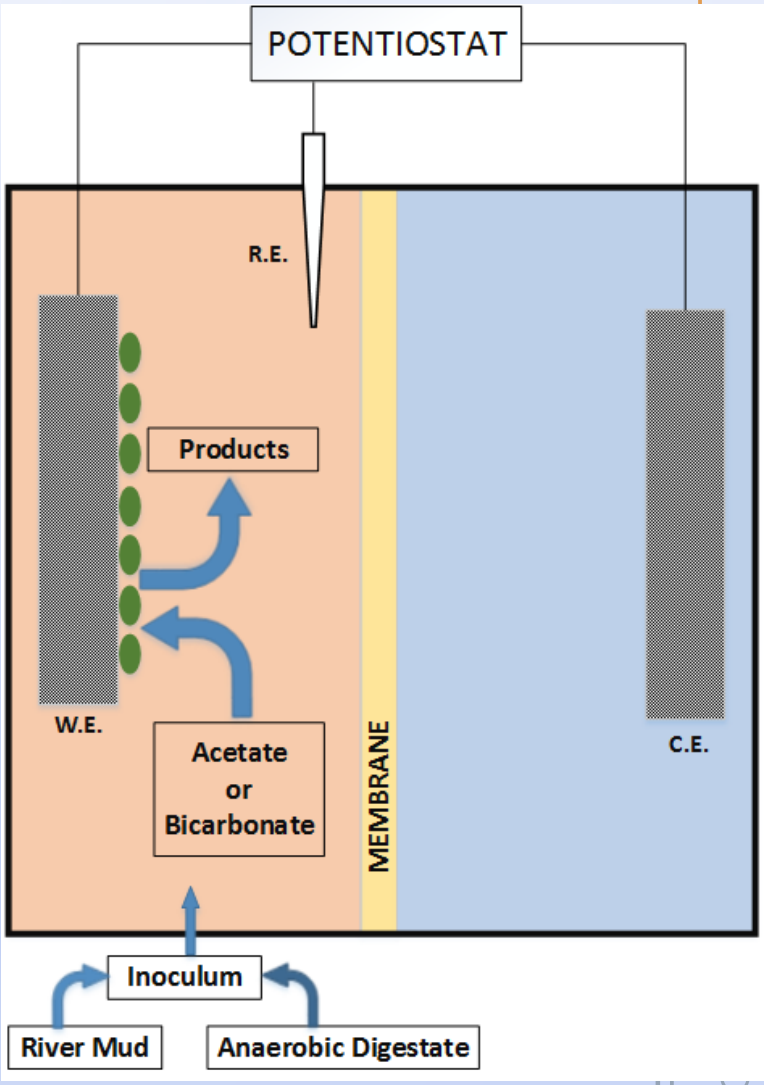
MATERIALS & METHODS

- **Batch operation**
- **Feed:** Synthetic medium

  Biocathodes: 2.5g/L sodium bicarbonate

  Bioanodes: 0.5g/L sodium acetate
- **Inocula:** River Mud (RM) or Anaerobic Digestate (AD)
- **Evaluated parameters:**

  Physicochemical, Electrical and Biological



START-UP STRATEGIES

1. Inoculum: River Mud

Biocathode -0,8V t = 0 → Biocathode -0,8V t = 3 weeks → Biocathode -0,8V t = 13weeks

1 Inoc.: RM Cathode → Cathode

2. Inoculum: Anaerobic Digestate

Biocathode -0,8V t = 0 → Biocathode -0,8V t = 3 weeks → Biocathode -0,8V t = 13weeks

2 Inoc.: AD Cathode → Cathode

3. Inoculum: River Mud

Bioanode +0,2V t = 0 → Potential change: Biocathode -0,8V t = 3 weeks → Biocathode -0,8V t = 13weeks

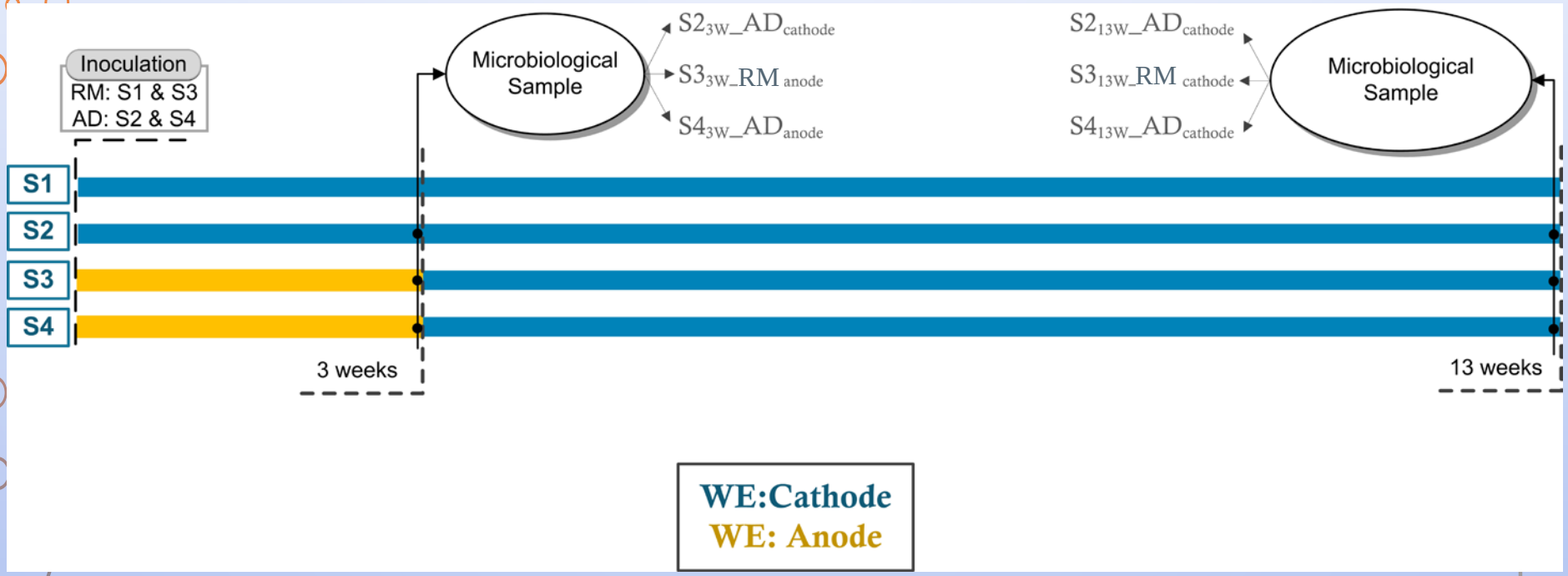
3 Inoc.: RM Anode → Cathode

4. Inoculum: Anaerobic Digestate

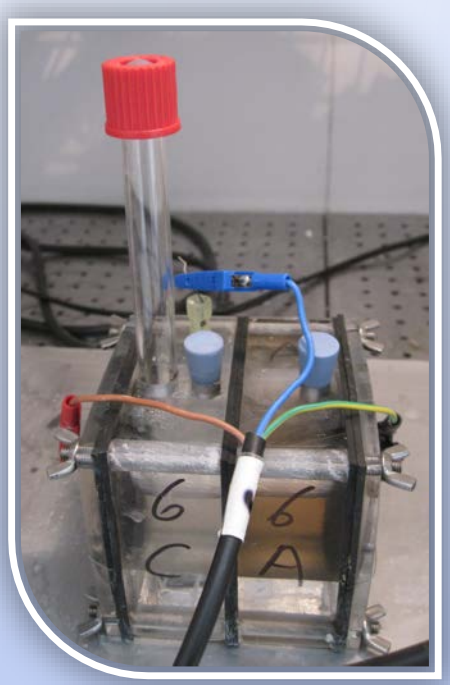
Bioanode +0,2V t = 0 → Potential change: Biocathode -0,8V t = 3 weeks → Biocathode -0,8V t = 13weeks

4 Inoc.: AD Anode → Cathode

MATERIALS & METHODS



MATERIALS & METHODS



- Strategies tested in triplicate for a total set-up of 12 cells

RESULTS

Strategy	Maximum current (A/m^2)		Comments
	3 weeks	13 weeks	
1st strategy	<0.01	<0.01	No current or products
2nd strategy	0.4	0.5	Around 2 weeks to firstly produce current
3rd strategy	0.6	1.0	Bioanodes produced current at the first cycle. Biocathodes took 4 days to produce current
4th strategy	0.7	0.4	Bioanodes produced current at the first cycle. Biocathodes took 3 days to produce current

1 **Inoc.: RM**
Cathode → Cathode

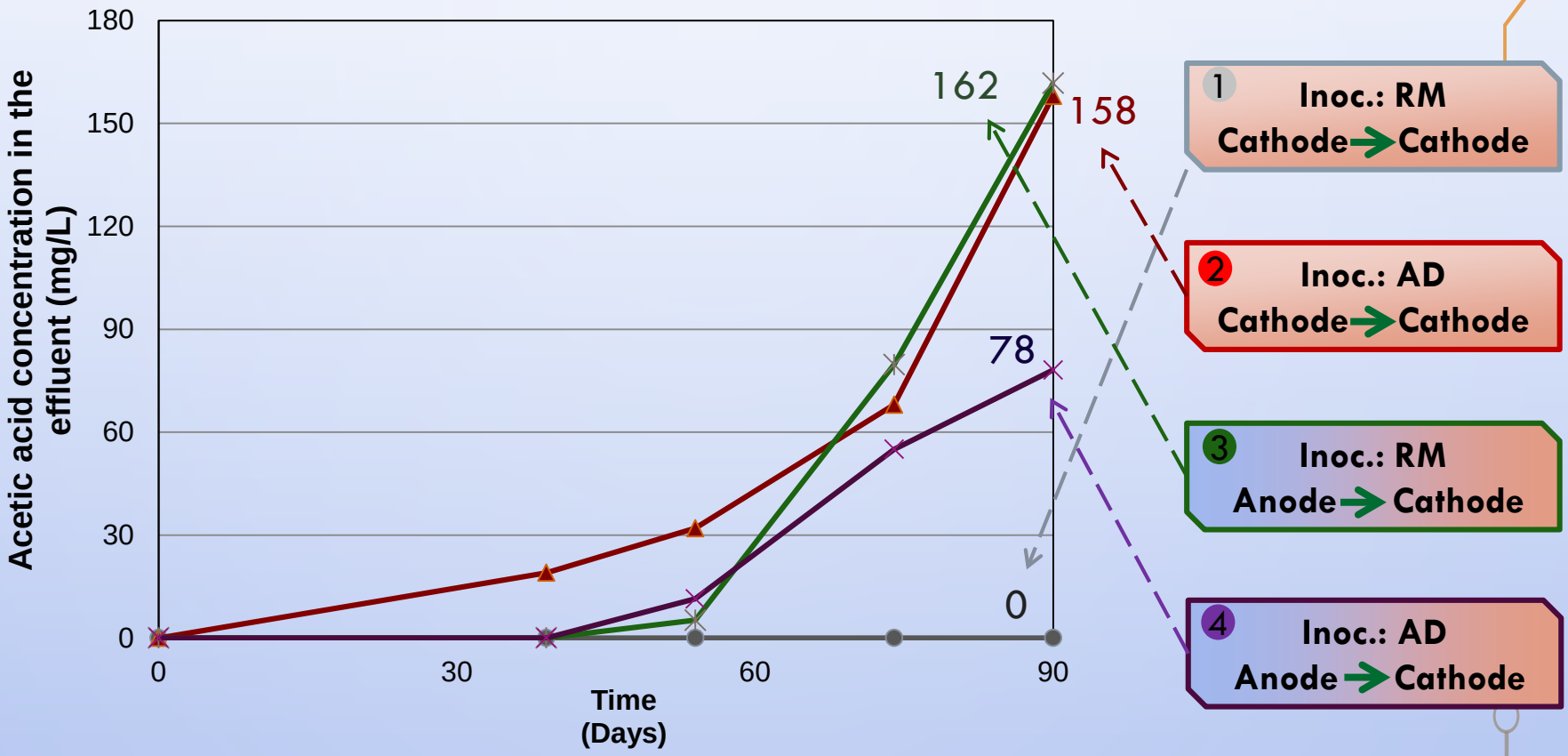
2 **Inoc.: AD**
Cathode → Cathode

3 **Inoc.: RM**
Anode → Cathode

4 **Inoc.: AD**
Anode → Cathode

RESULTS

- Chemicals production:



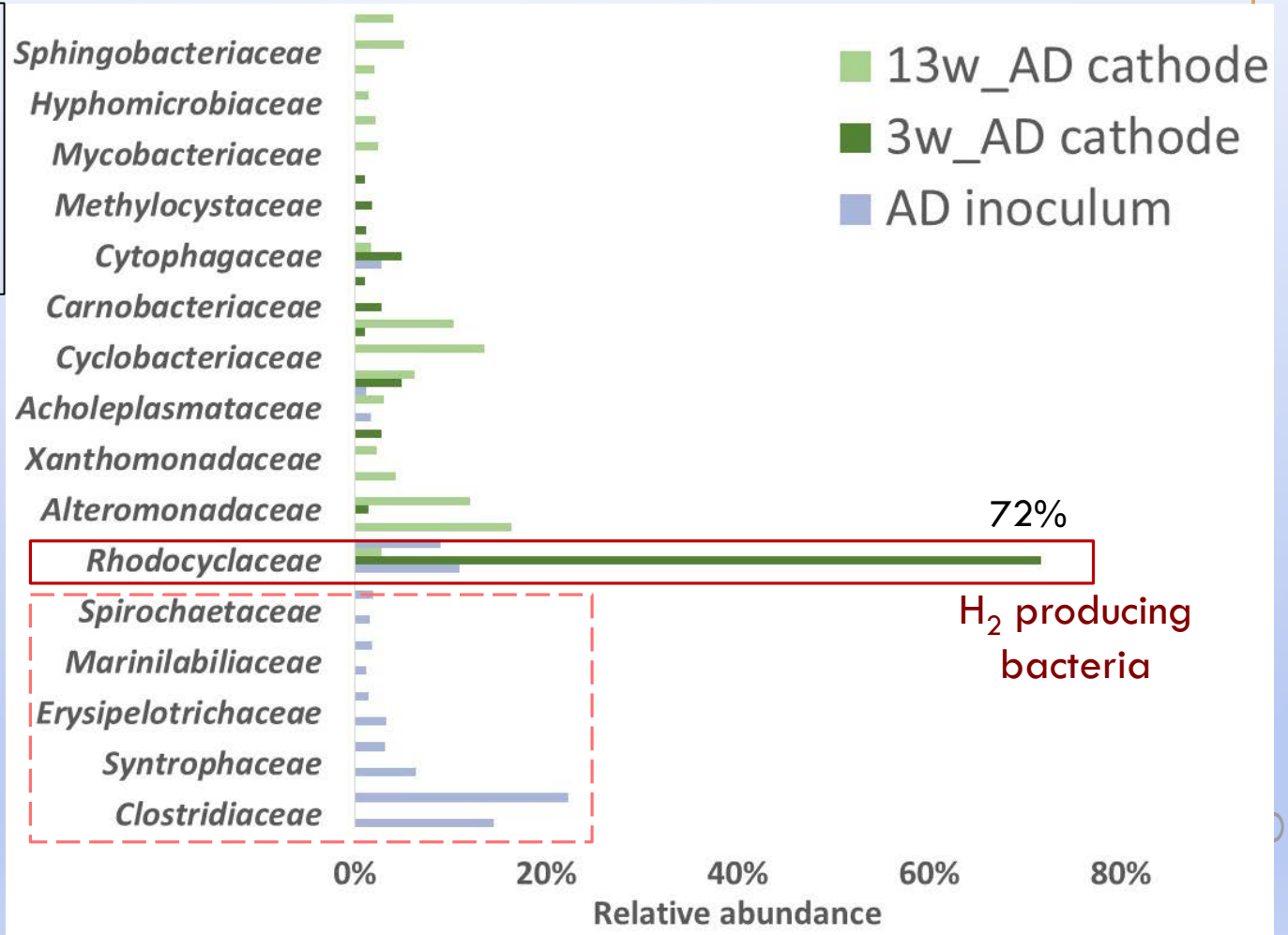
- No gas production quantified due to leakages
- Hydrogen gas detected on cathode chambers after week 3 (Strategies 2, 3 & 4)
- No alcohols were detected in the effluent

MICROBIOLOGY RESULTS

➢ 2nd STRATEGY: 2 **Inoc.: AD Cathode → Cathode**

No microbial analysis was performed for 1st Strategy due to absence of biofilm

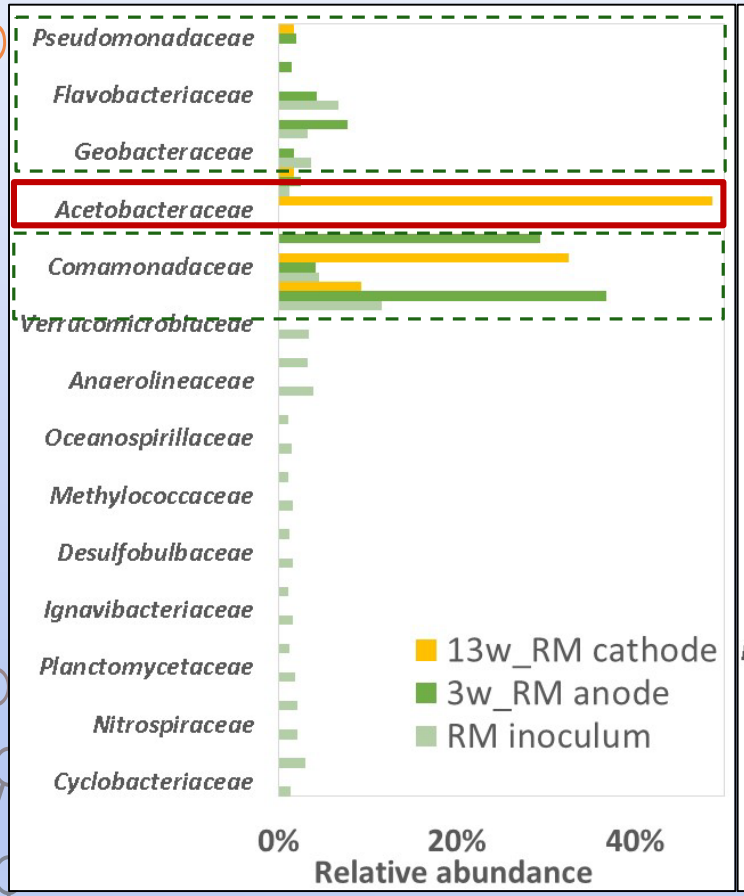
Inoculated biocathode appearence

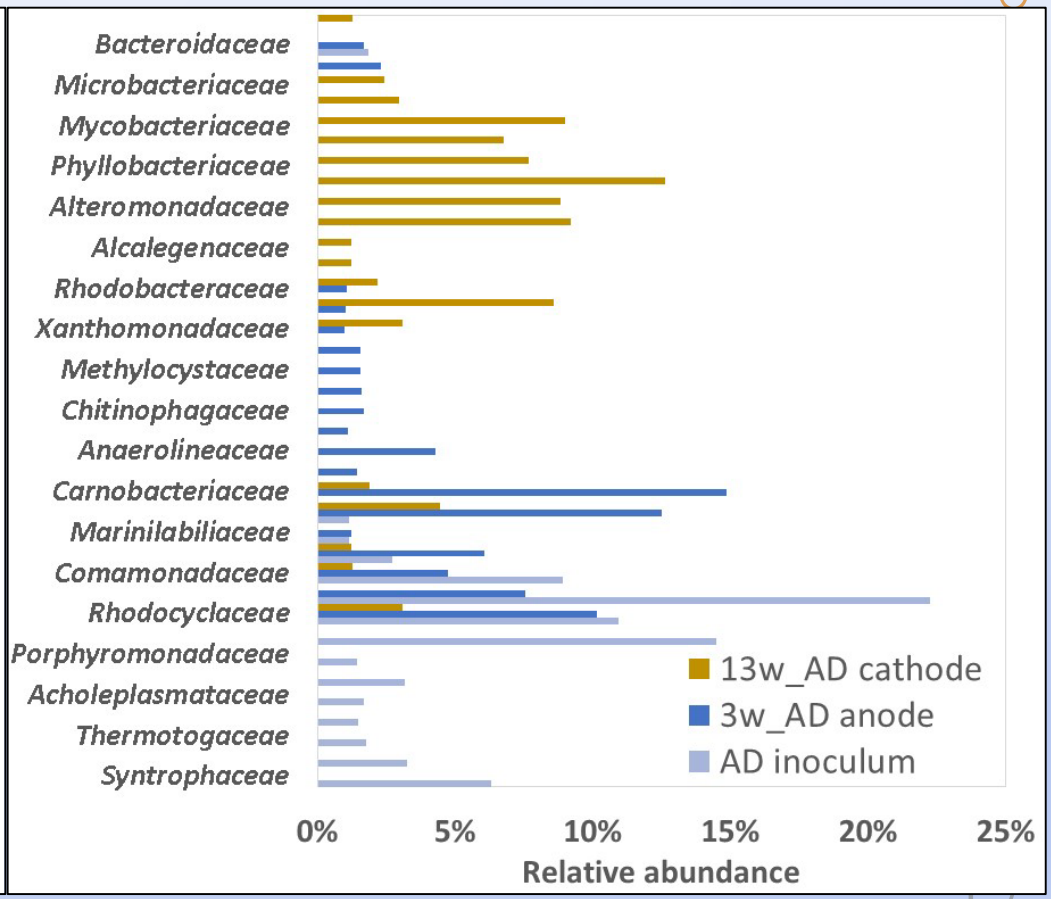


MICROBIOLOGY RESULTS

➢ 3rd STRATEGY: 3 **Inoc.: RM Anode → Cathode**

➢ 4th STRATEGY: 4 **Inoc.: AD Anode → Cathode**

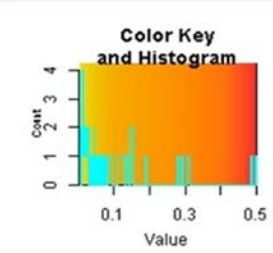




SHARP ENRICHMENT

HIGHLY DIVERSE BIOFILM

MICROBIOLOGY RESULTS



Strategy 2:

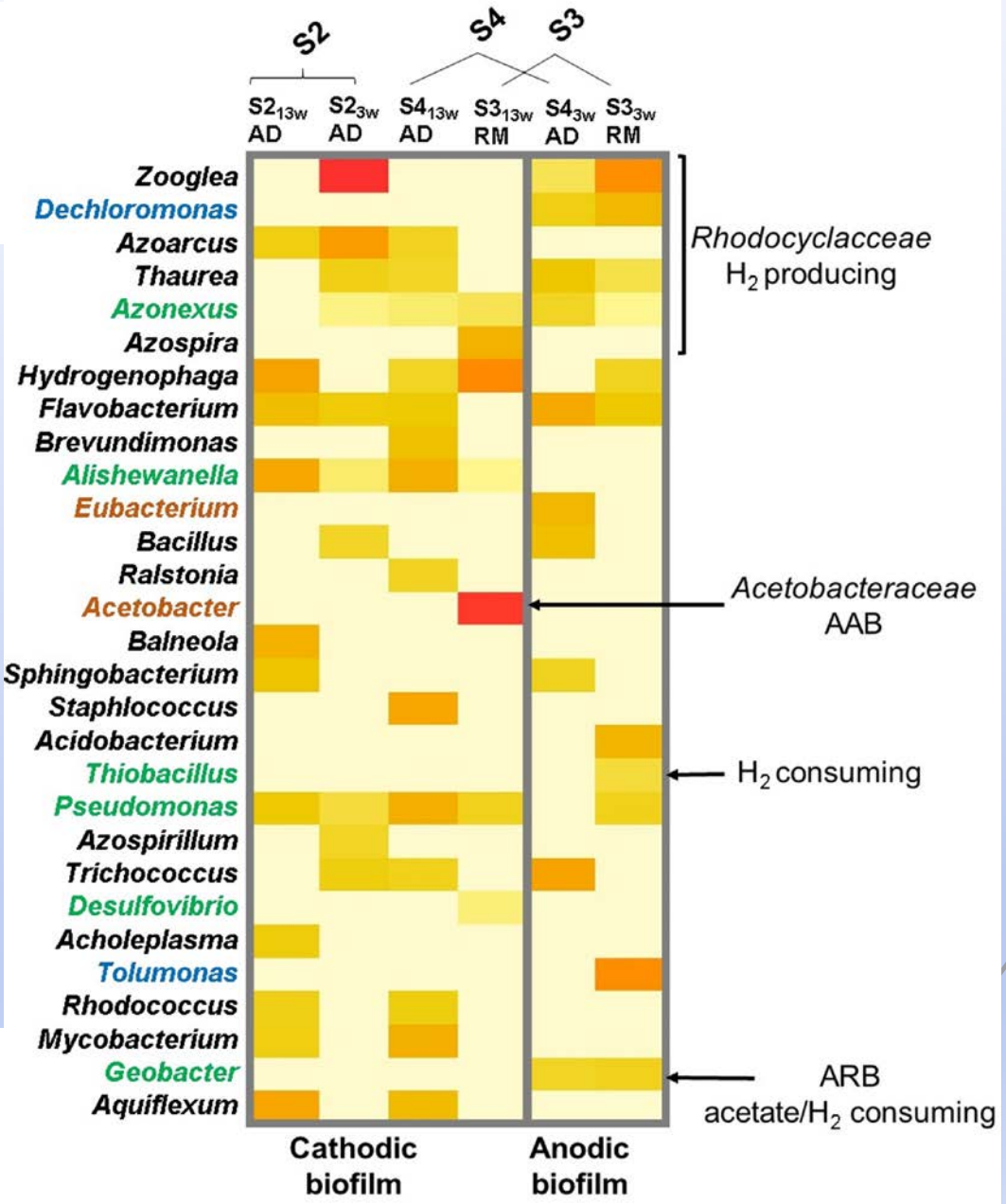
Enriched in a short period of time in hydrogen producing bacteria

Strategy 3:

Enrichment in AAB & H_2 producers

Strategy 4:

Less specified than other strategies



CONCLUSIONS

Strategy	Electrical behaviour	Chemicals production	Microbiology	Strategy Outline
1st strategy	No current generation	No chemicals generation	No biofilm	1 **Inoc.: RM** **Cathode → Cathode**
2nd strategy	**Lower current generation**	**High HAc production. H_2 detected.**	**Specialised biofilm. Predominancy of H_2 producing bacteria.**	2 **Inoc.: AD** **Cathode → Cathode**
3rd strategy	**Highest current generation**	**High HAc production. H_2 detected.**	**Specialised biofilm. Predominancy of HAc producing bacteria.**	3 **Inoc.: RM** **Anode → Cathode**
4th strategy	High current generation	Lower Acetic Acid production. H_2 detected.	Non specialised biofilm. No predominancy of one single type of bacteria.	4 **Inoc.: AD** **Anode → Cathode**

CURRENT WORK

❖ Optimisation

➢ Feed supply

Bicarbonate vs gaseous CO_2

➢ Microbial community

Archaea inhibition

➢ Other possible optimisation targets

Membranes

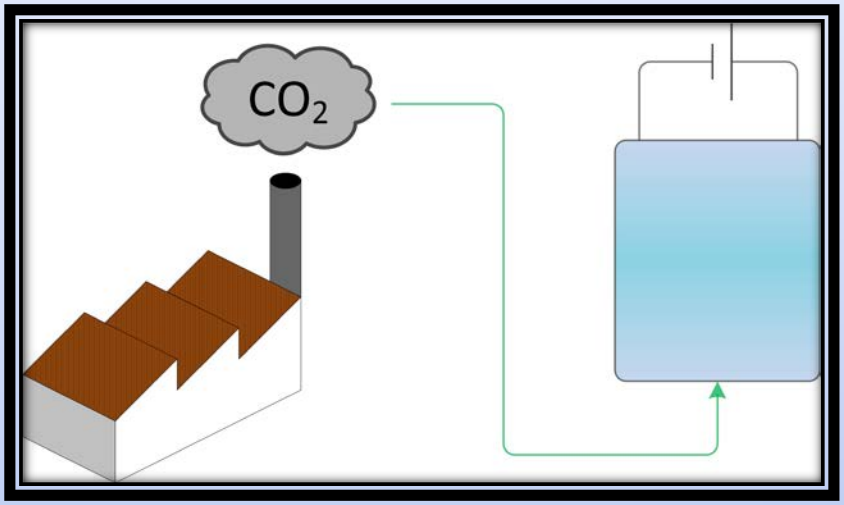
Electrode materials

FUTURE WORK

❖Technology application

➢CO_2 rich exhaust gas as feed

Issues to overcome: Other gases poisoning biofilm (SO_x, NO_x, O_2)



➢Scaling-up

Issues to overcome: Overpotentials, expensive materials (Membrane, electrodes)

THANK YOU FOR YOUR ATTENTION

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Ana Sotres thanks "Junta de Castilla y Leon" for postdoctoral contract associated to project ref: LE060U16.

The authors acknowledge the funding of the Spanish "Ministerio de Economía y Competitividad" via project CTQ2015-68925-R.

Raúl Mateos thanks the Spanish "Ministerio de Educación, Ciencia y Deporte" for the FPU predoctoral grant FPU14/01573.

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