Turning CO_2 Into High-Performing and Biodegradable Plastic Materials

Mariana Paredinha Araujo, Scientist
Avantium

Avantium

avantium

EURONEXT
Ticker: **AVTX**
Amsterdam & **Brussels**

Headquartered in **Amsterdam**

150+
patent families

280
>75% scientists
20+ nationalities

Renewable Polymers

FDCA from plant-based sugars

Polymerization from FDCA into PEF

PEF: 100% plant-based & recyclable packaging material

Volta & CorpTech

Volta: electrocatalysis platform to produce high value chemicals

Unlocking CO_2 as a new carbon source for the chemicals and the plastics industry

R&D Solutions

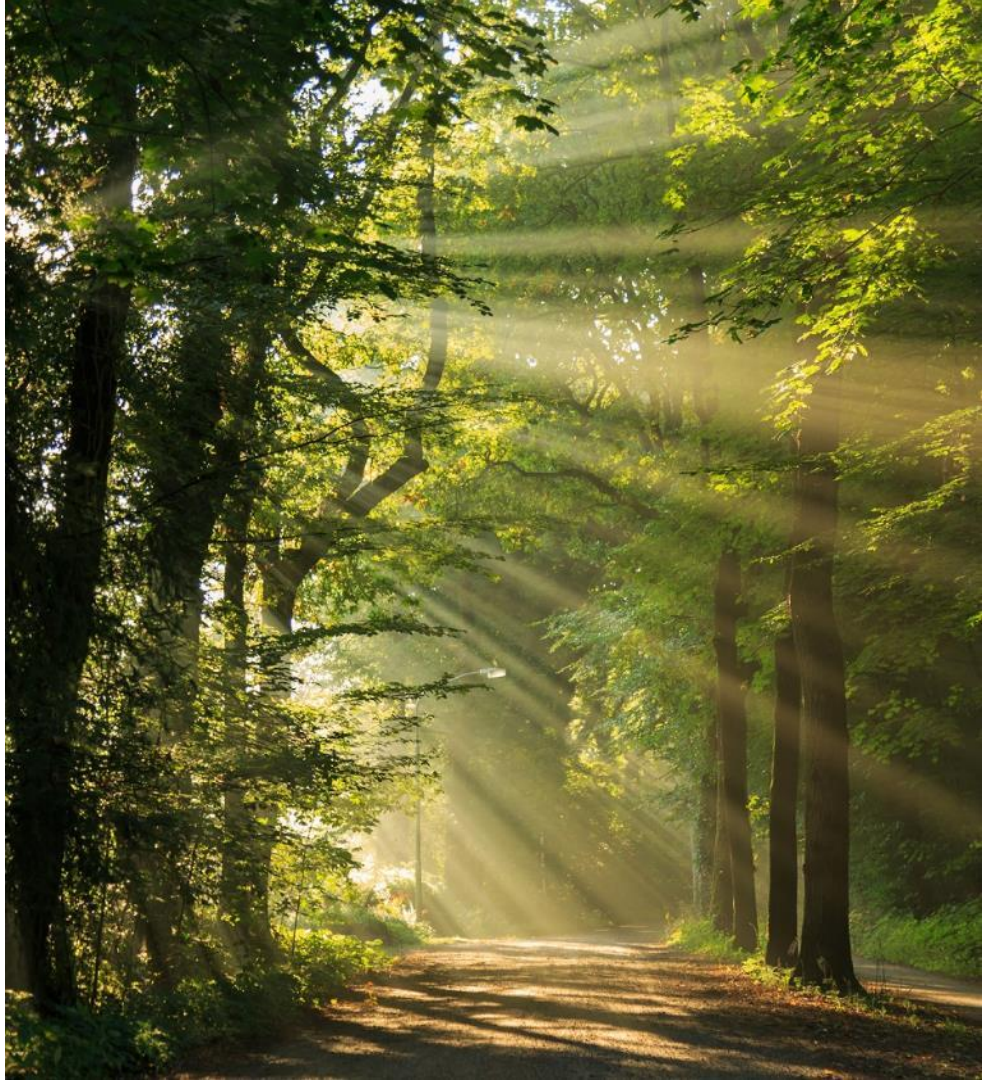
Foundational Technical Expertise

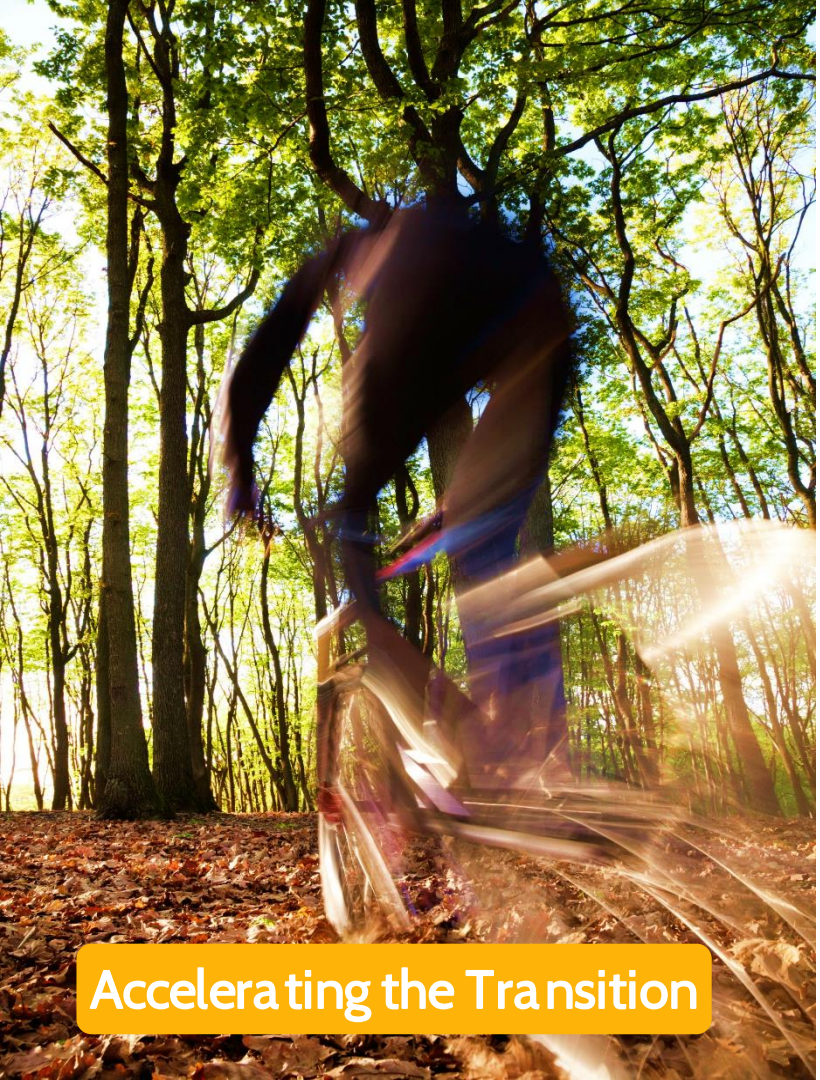
Leading Systems and Services Provider for Catalyst R&D

Our Vision

We believe in a fossil-free world.

Let’s Go.





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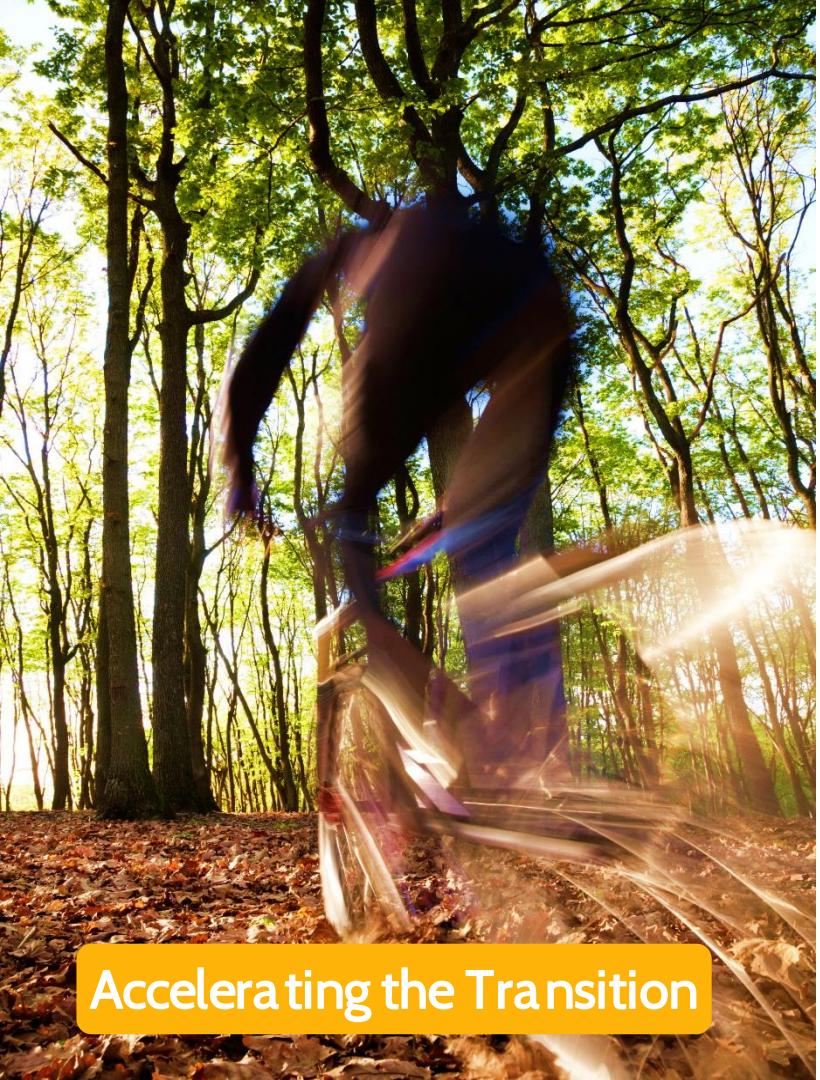
There are only three renewable carbon sources available in this world…

Plant-Based	Air-Based	Man-Made
Rediscover	*Reroute*	*Repurpose*
Glucose as Building Block	CO_2 Conversions	Chemical Recycling

…that enable a circular economy



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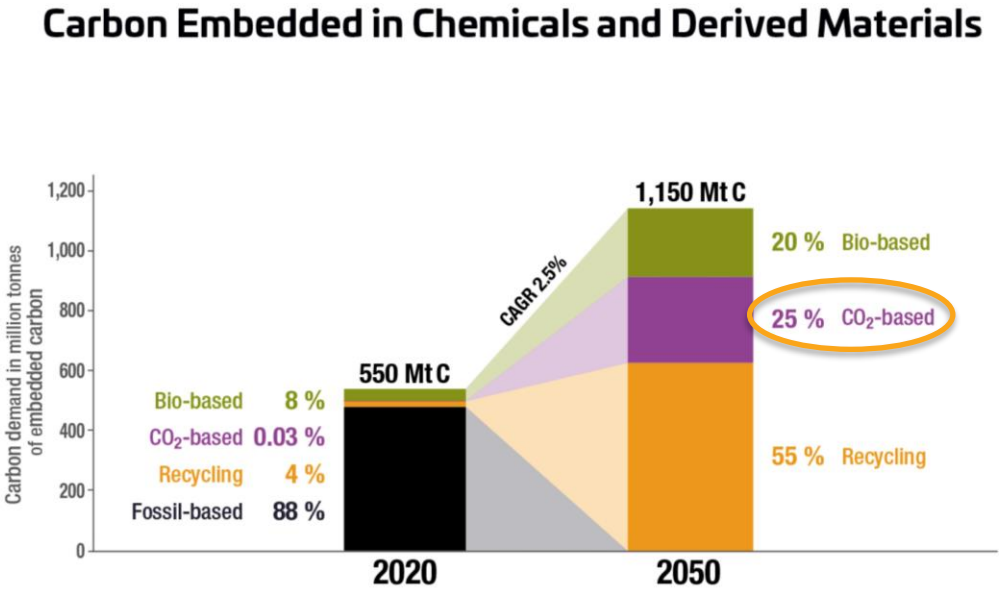
Unlocking CO_2 as renewable carbon source



Unlocking CO_2 as renewable carbon source to switch to 100% renewable feedstock by 2050

Renewable Carbon Initiative – Carbon Flows Report, nova-institute 2023

Volta is a Cutting-Edge Technology

We use electricity as a renewable energy source.
This technology is ***Electrochemistry***

We use electrons as a reagent.
This makes it the ***cleanest*** *of technologies*

We are unique in converting CO_2 into sustainable ingredients

2012 Volta founded

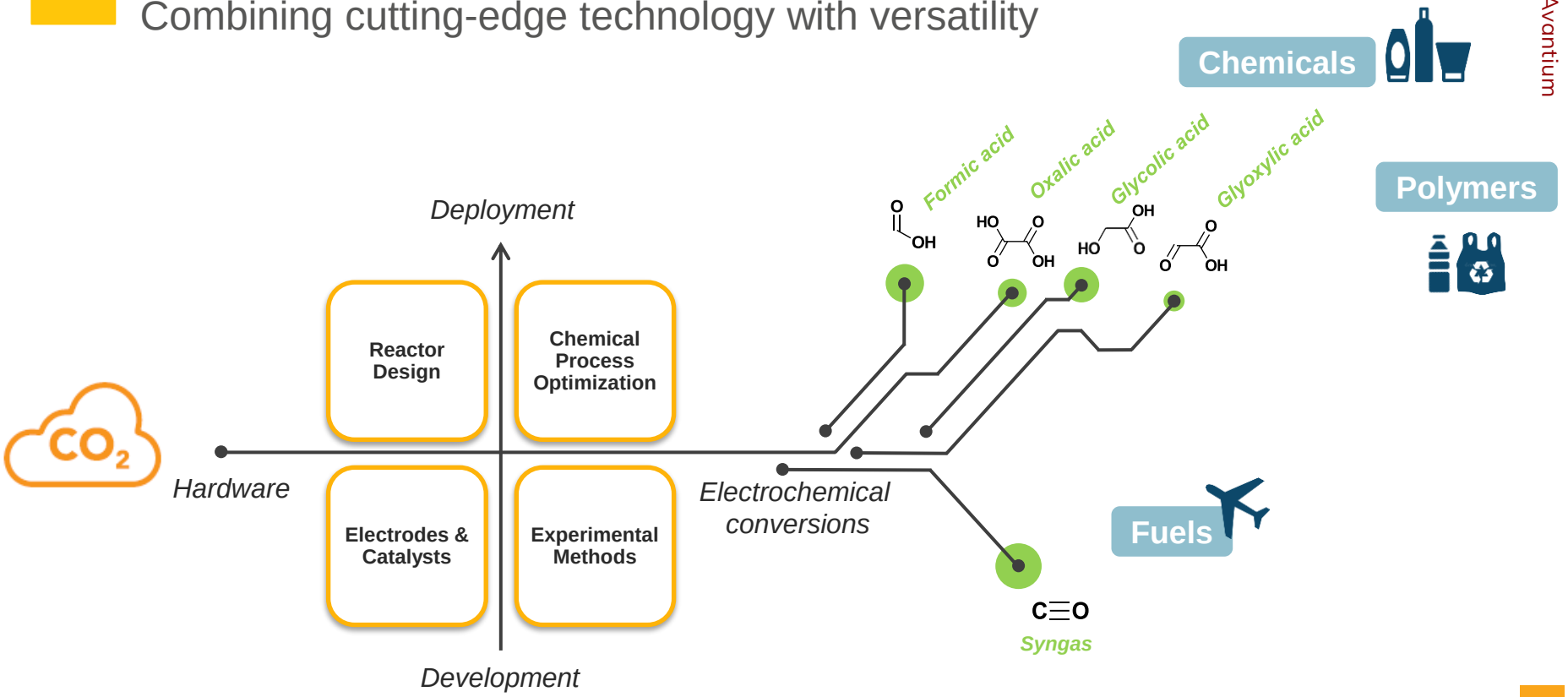
2016 Acquisition of LIQUIDLIGHT Princeton start-up with > $30M invested

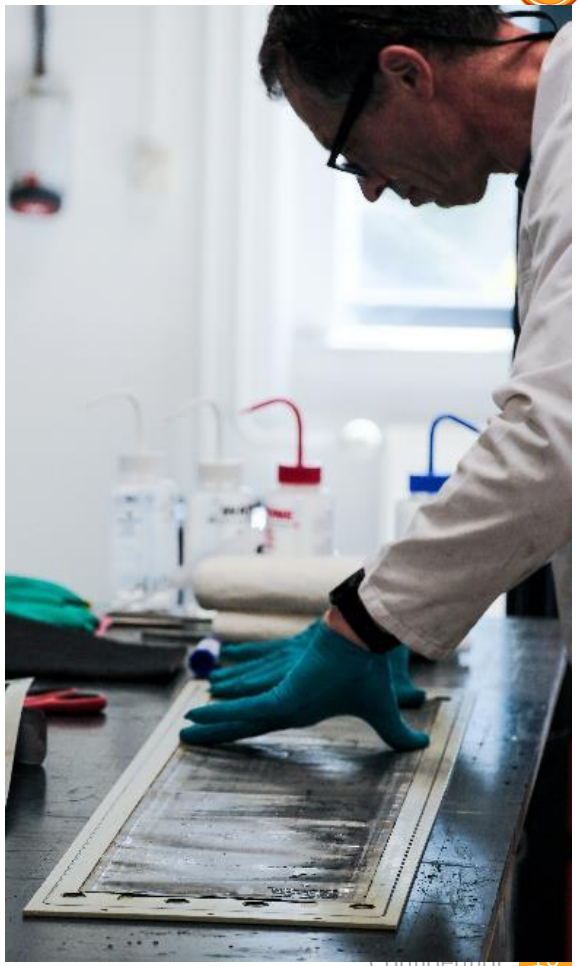
2023 Technology frontrunner: >35 collaborations; extensive IP portfolio

Excellent electro-catalysis expertise	Winning technology for CO_2 conversion	Powerful economics by paired electrolysis	Ready to scale out	World leading IP position
				
Avantium is a leading catalysis company	High productivity High energy efficiency	Co-production: creating value at both electrodes	Scale out, not scale up Developing TRL6 scale	32 IP families 112 IP rights (36 US)
CONVERSION	INGREDIENTS	PROCESSES	ENGINEERING	DEPLOYMENT

Volta Technology

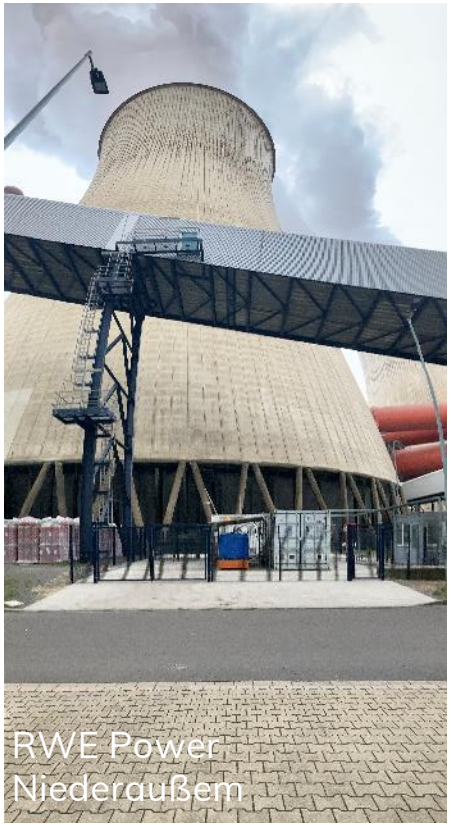
Combining cutting-edge technology with versatility

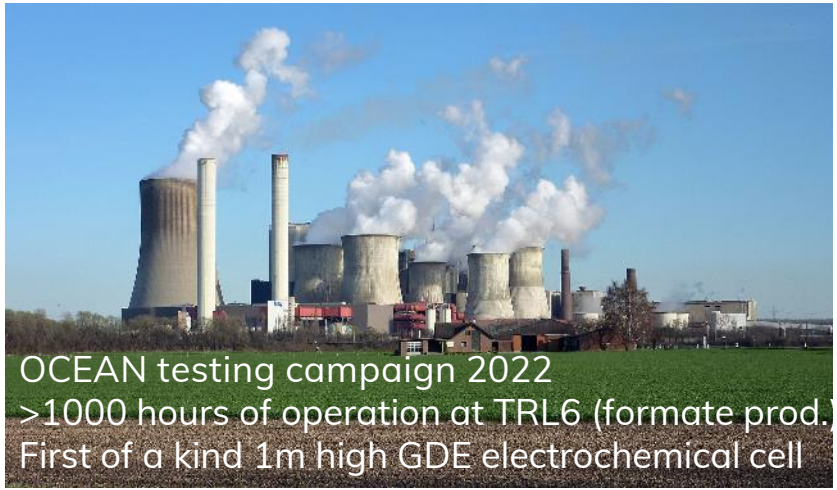




Pre-pilot demonstrators

Pre-pilot demonstrator for formate production


RWE Power
Niederaußem


OCEAN testing campaign 2022
>1000 hours of operation at TRL6 (formate prod.)
First of a kind 1m high GDE electrochemical cell

Outlook

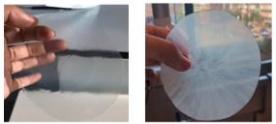
CO_2 conversion	Formate production	Formic acid production concentration
0.25 kg/hr	0.23kg/hr	N/A
1.63 kg/hr	1.5 kg/hr	1.5 70%+

Value chain

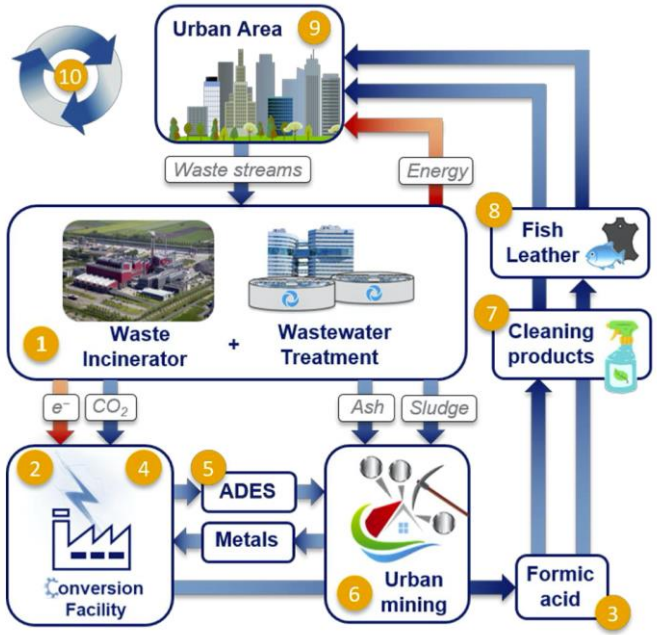
CO_2 → Formic Acid

- Energy production
- Formic acid market
- Feedstock for microbial conversion

Carbon negative monomers and polymers from CO_2



WATER PROOF Urban Symbiosis



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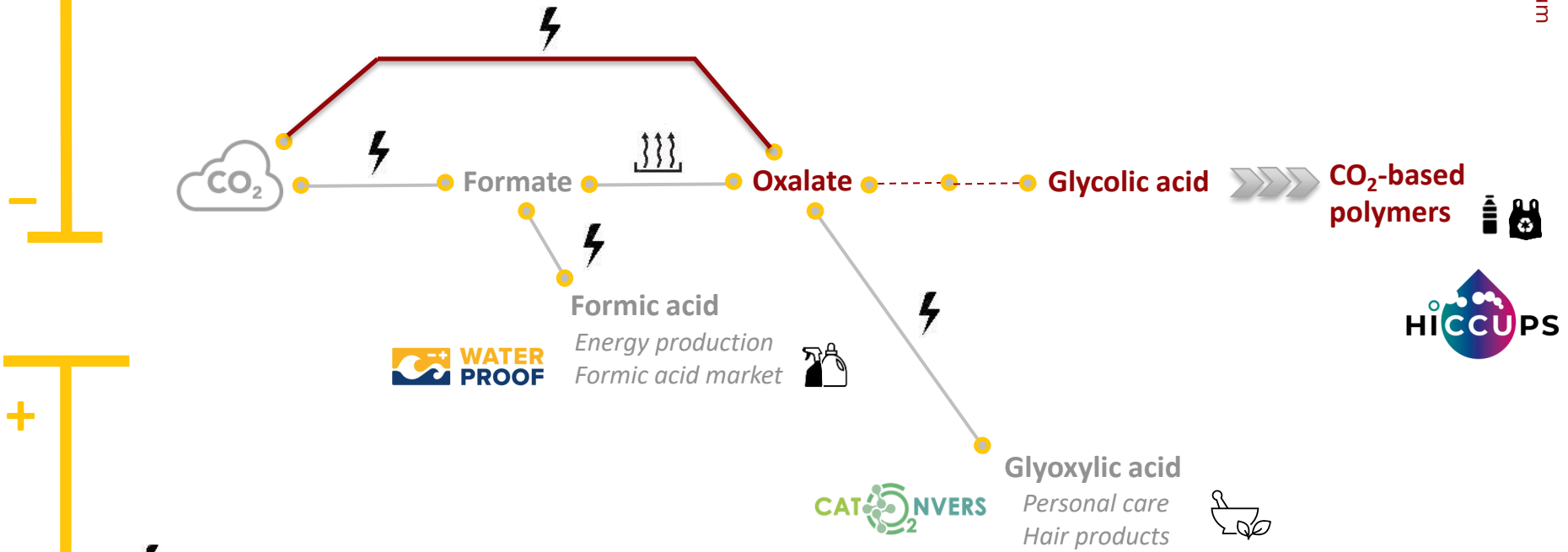
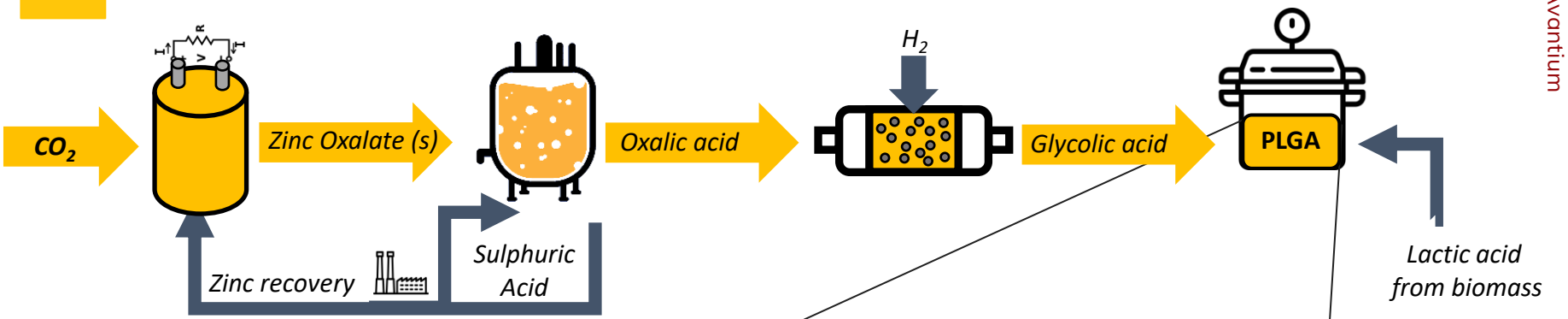
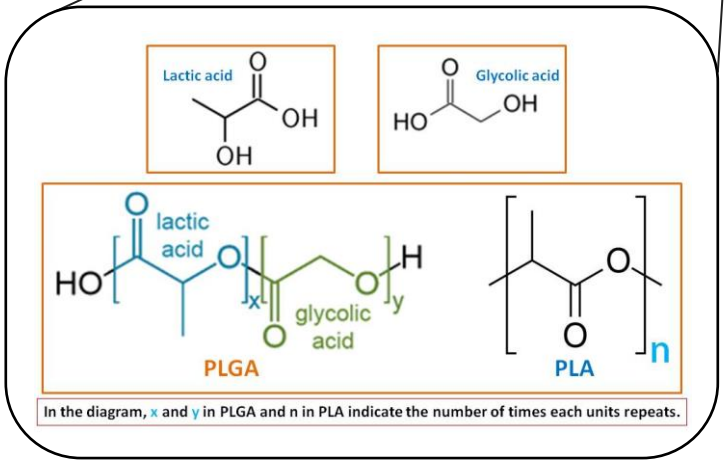
Avantium's alternative routes to CO_2 valorization



CO2-based monomers and polymers from CO_2



90% GA potentially
90% CO_2-based



Accelerating the transition to CO_2-based polymers

Avantium and SCGC partner to bring CO_2-based polymers to pilot phase

AMSTERDAM, 29 June 2023, 18:00 hrs CEST – Avantium N.V., a leading technology provider in renewable chemistry, announces that it has agreed to partner with SCG Chemicals Public Company Limited ("SCGC"), a leading integrated chemical player in Asia and an innovator of chemical innovations and solutions. Under this partnership, Avantium and SCGC agreed to further develop CO_2-based polymers and to scale-up to a pilot plant with an indicative capacity of 10 tonnes per annum.

Avantium awarded €1.5 million EU grant to demonstrate the electrochemical conversion of CO_2 into sustainable plastic materials

AMSTERDAM, 25 May 2023, 17:45 hrs CEST – Avantium N.V., a leading technology provider in renewable chemistry, announces that it has been awarded a €1.5 million grant by the EU Horizon Europe programme for its participation in the research and development programme HICCUPS[1]. This programme aims to demonstrate the utilisation of CO_2 as a feedstock for the production of polyesters. The €1.5 million grant will be paid out in

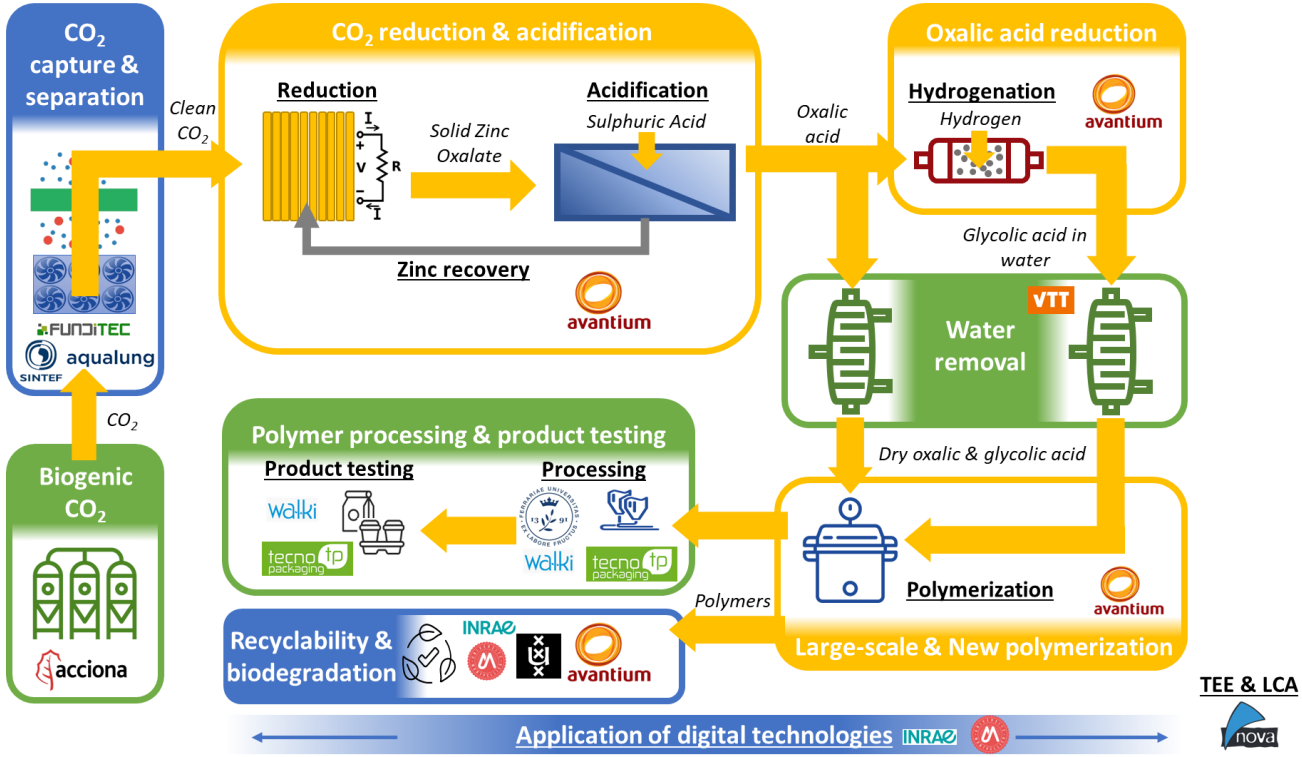
HORIZON-JU-CBE-2022-IA-01 Biogenic carbon capture and use (CCU) for circular bio-based products

Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

HICCUPS Project



Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the Bio-based Industries Consortium. Neither the European Union nor the Bio-based Industries Consortium can be held responsible for them.

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Barrier properties of PLGA

Oxygen permeability (OP) and Water permeability (WP) for PLGA copolymers at 70% RH and 30 °C

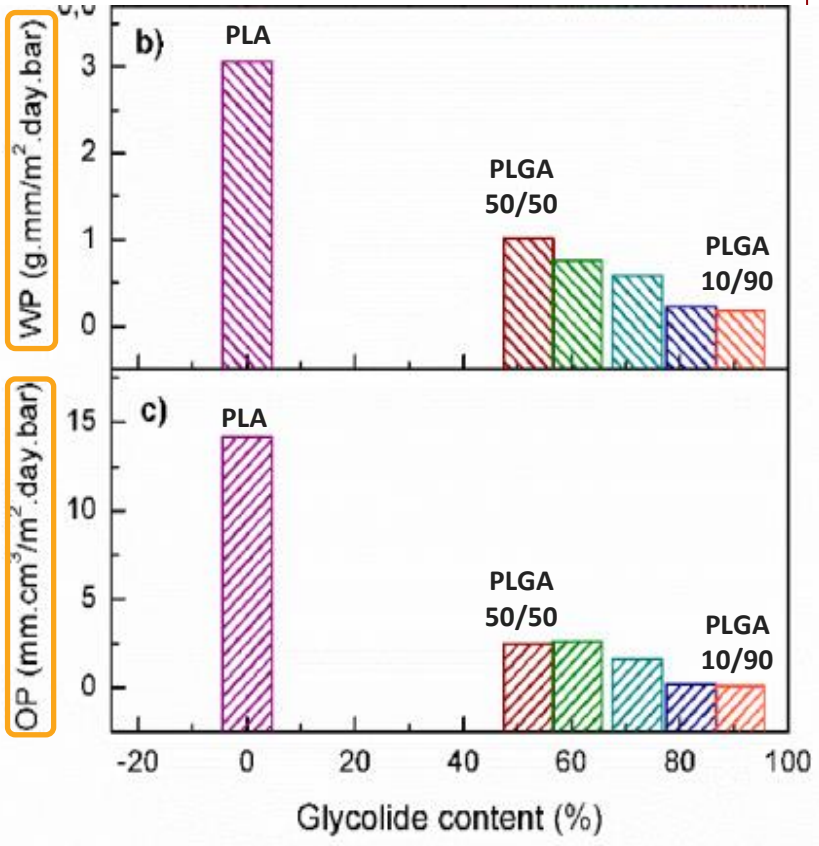
Increasing GA content (50 –> 90%)

Increased barrier to water vapor

Increased barrier to O_2

Very interesting as barrier polymers with application in areas such as films for packaging

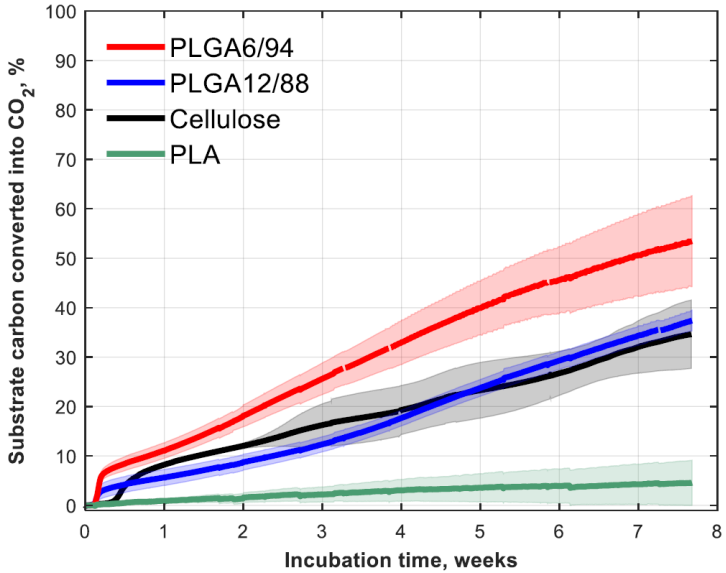
Film thickness = 0.17 mm



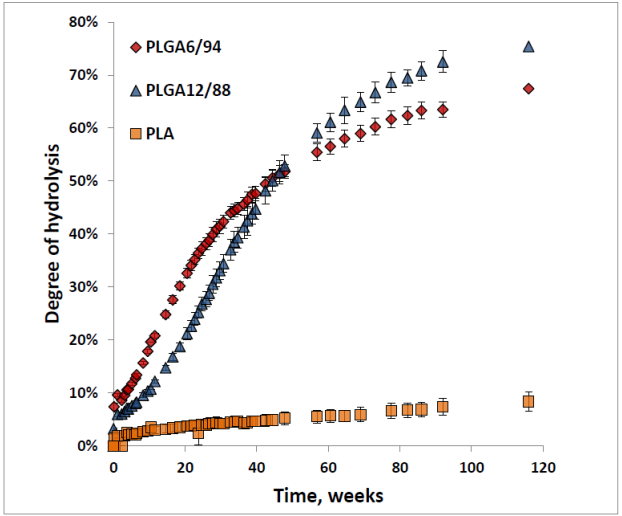
Murcia Valderrama, M.A. et al. *ACS Appl. Polym. Mater* **2020**, *2*, 2707-2718.

Biodegradability of PLGA

Ambient temperature soil (bio)degradation, compostable



Non-enzymatic hydrolytic degradation of PLGA determined with ^{1}H NMR



Y. Wang *et al.*, *Polymers* **2022, 14**, 15.

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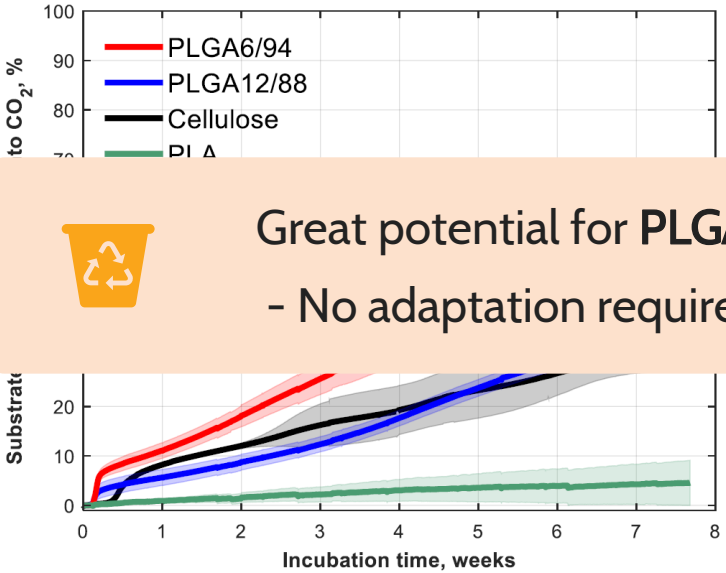

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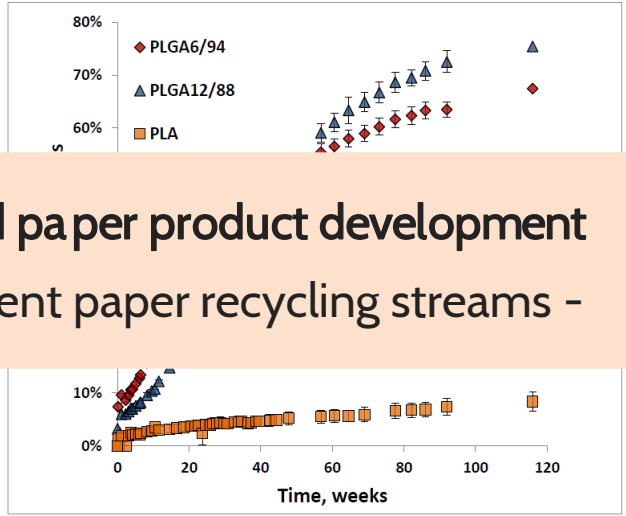
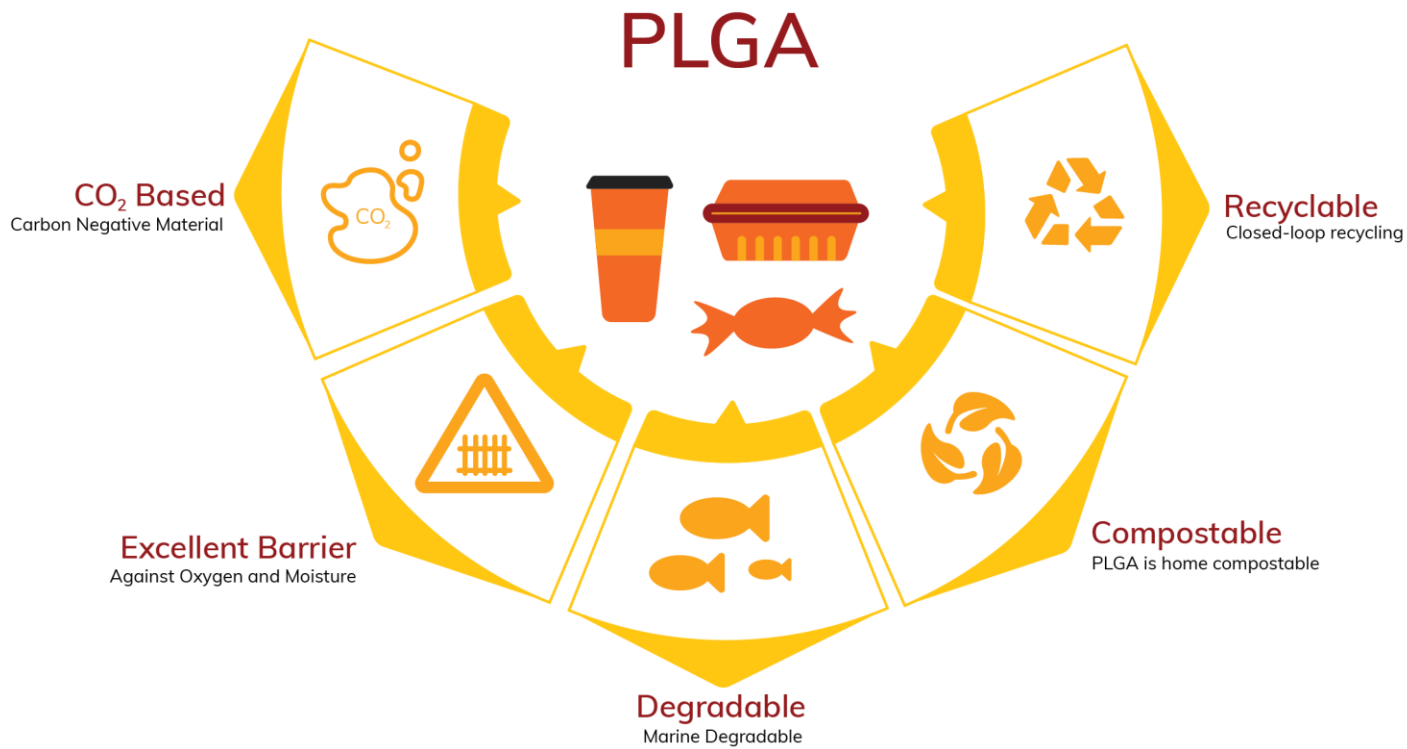


Great potential for **PLGA-coated paper product development**

- No adaptation required in current paper recycling streams -

Y. Wang *et al.*, *Polymers* **2022, 14**, 15.

PLGA in a nutshell



Finding the right partners along the value chain

Partners aligned on sustainability goals

Feedstock

CO_2 and electricity providers

More and more CO_2 capture facilities are being built at emission sites

Scaling up

Engineering parties

Including the manufacturing of large electrodes and electrochemical cells

Purification

Downstream Processing

Creating a resource efficient process to meet product specifications

Off-take

Application testing

Identifying applications for off-take agreements

End-of-life

Environmental impact

Quantifying the environmental impact to reduce the carbon footprint

Avantium

Thank you!

Our strong network provides us access to EU-grants and an extensive network of collaborators

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Funded by the European Union