IOCPC 2026 Conference

PHOTOCATALYTIC UPCYCLING OF BIO-BASED MICROPLASTICS UNDER AMBIENT CONDITIONS USING NANOSTRUCTURED TITANIA-BASED CATALYSTS

ARISTOTLE UNIVERSITY OF THESSALONIKI

PhotoUpPlas

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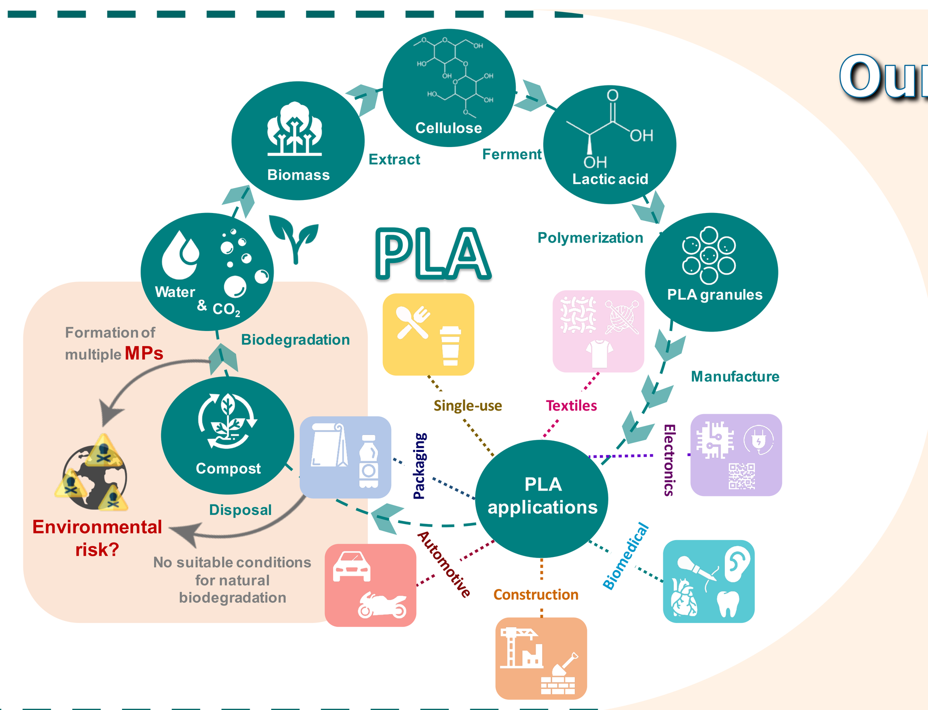
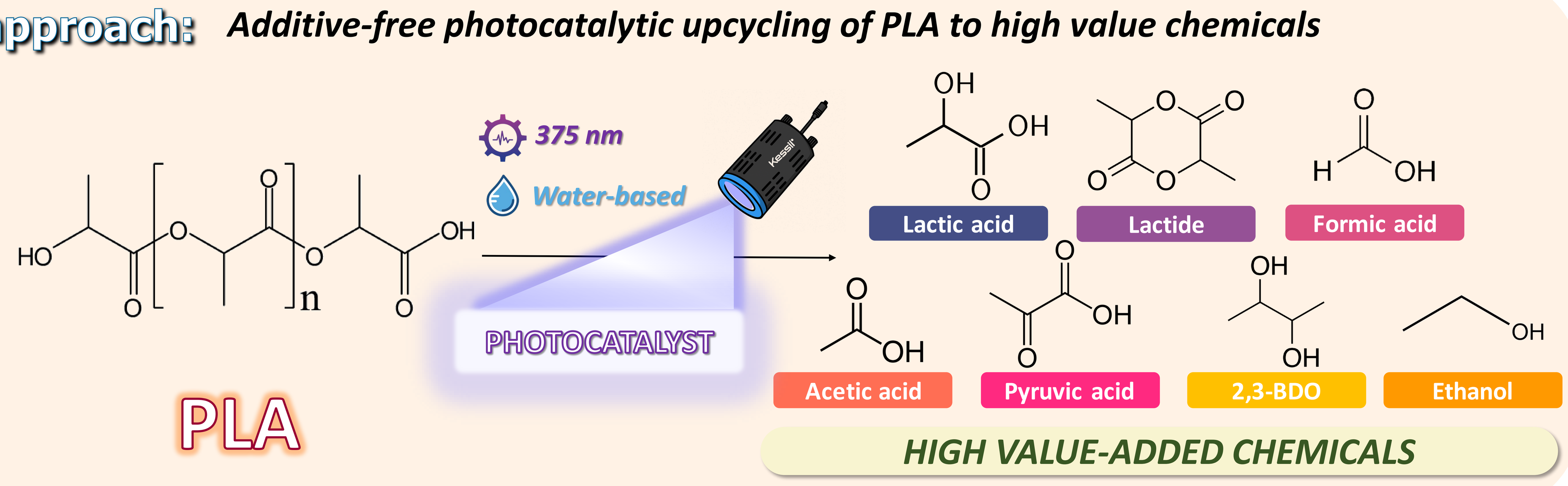
The problem:

The widespread perception that PLA is a biodegradable polymer often leads to a misunderstanding that it will degrade readily in the natural environment. Under realistic environmental conditions, PLA rarely fully degrades into CO_2 and water and instead can fragment into microplastics.

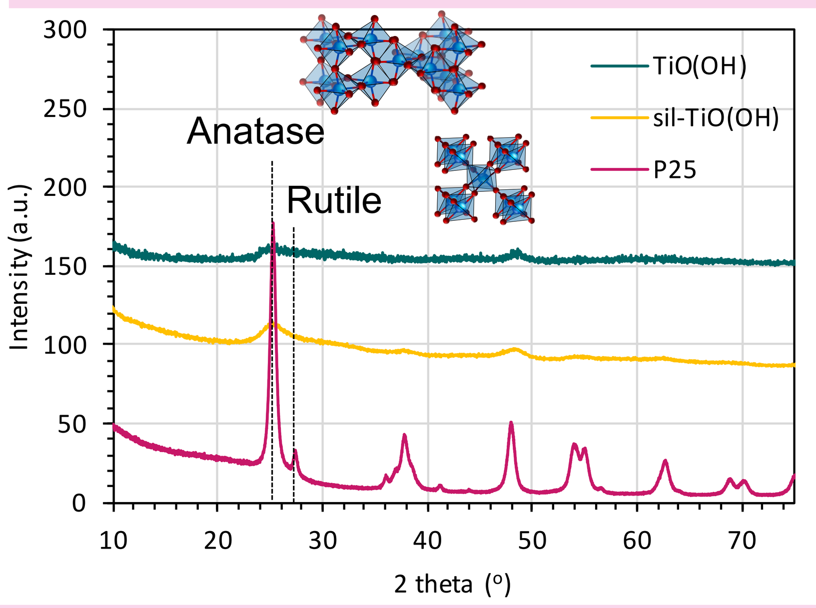


Our approach: *Additive-free photocatalytic upcycling of PLA to high value chemicals*

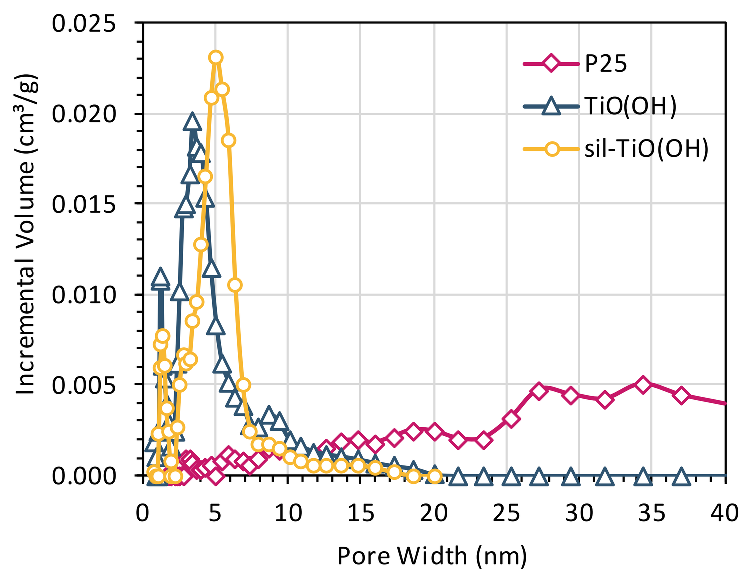


Material Synthesis & Characterization

XRD

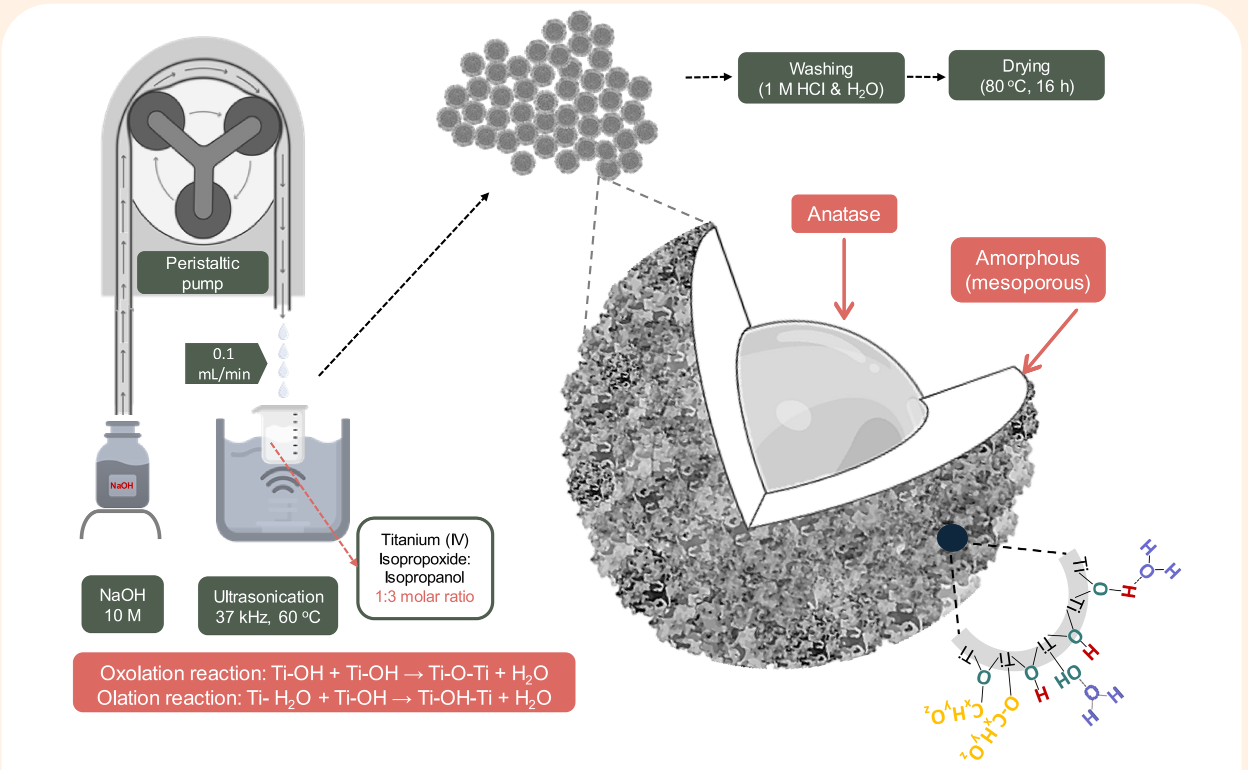


N_2 Sorption



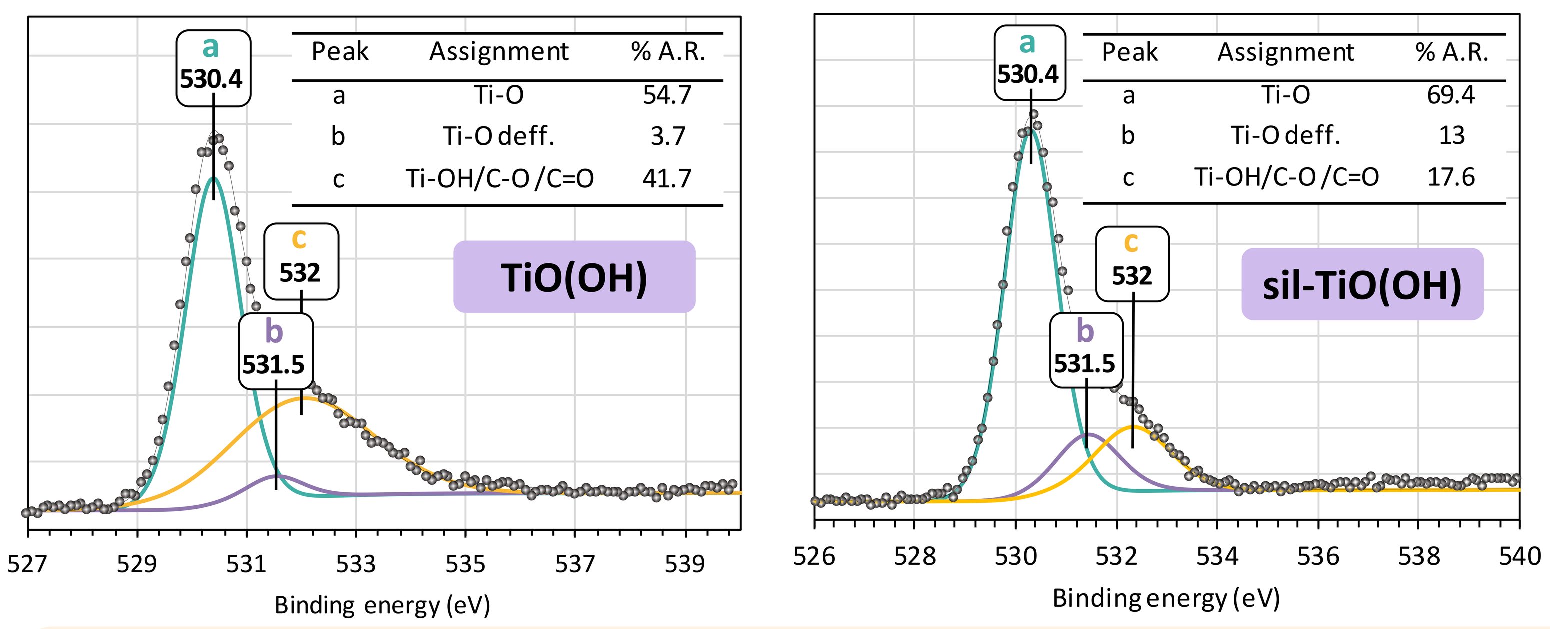
Materials	S_{BET} (m^2/g)	V_{total} (cm^3/g)	V_{mp} (cm^3/g)
P25	56	0.19	-
sil-TiO(OH)	359	0.38	0.07
TiO(OH)	445	0.40	0.082

Novel Titanate (Hydroxy)oxide TiO(OH) synthesis:



✓ sil-TiO(OH): absence of ultrasonication-*"silence mode"* (magnetic stirring synthesis)

XPS



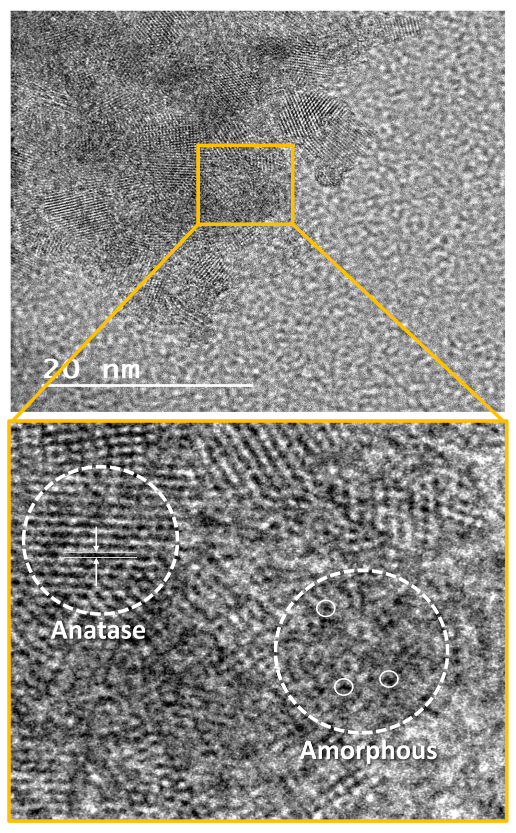
TiO(OH):

Peak	Assignment	% A.R.
a (530.4)	Ti-O	54.7
b (531.5)	Ti-O deff.	3.7
c (532)	Ti-OH/C-O/C=O	41.7

sil-TiO(OH):

Peak	Assignment	% A.R.
a (530.4)	Ti-O	69.4
b (531.5)	Ti-O deff.	13
c (532)	Ti-OH/C-O/C=O	17.6

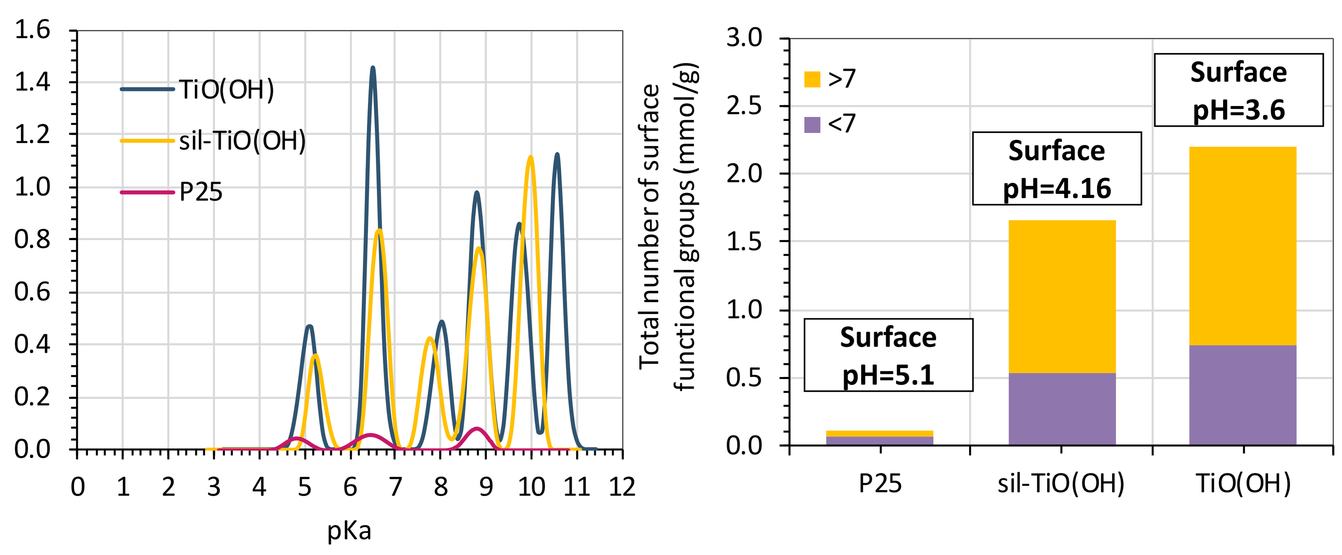
TiO(OH) TEM images



TiO(OH):

- Higher surface functional groups.
- Acidic surface pH.
- Large hydroxylated surface area.
- Distinct microporous features.
- Well-ordered pores (2-5 nm)→Presence of larger micropores and small mesopores.

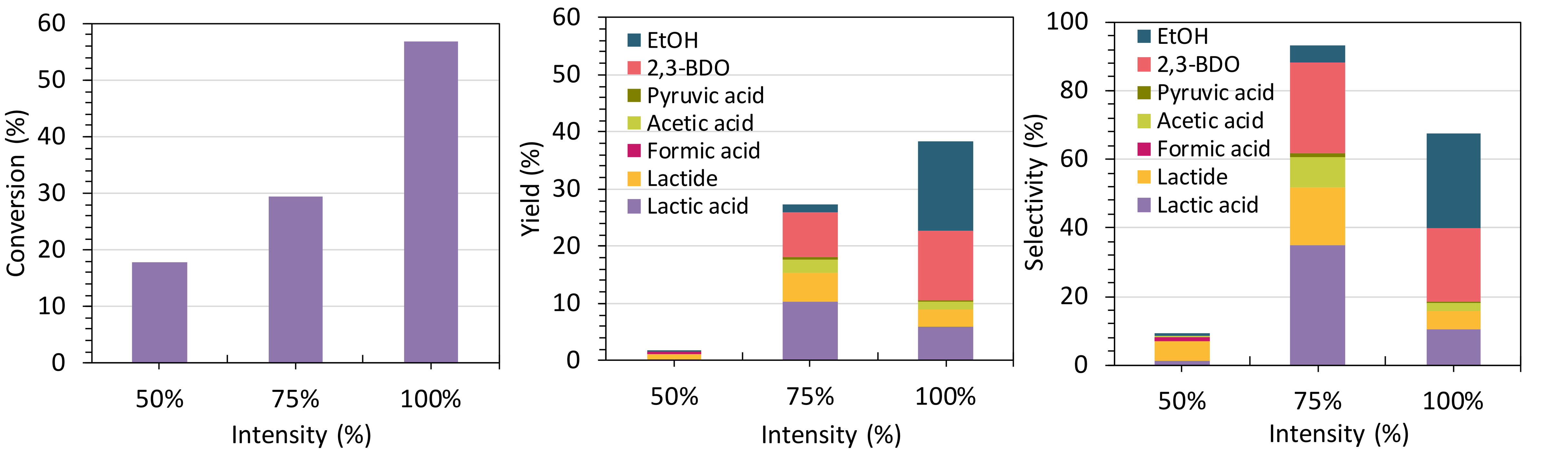
Potentiometric titration



PLA PHOTOCATALYTIC UPCYCLING

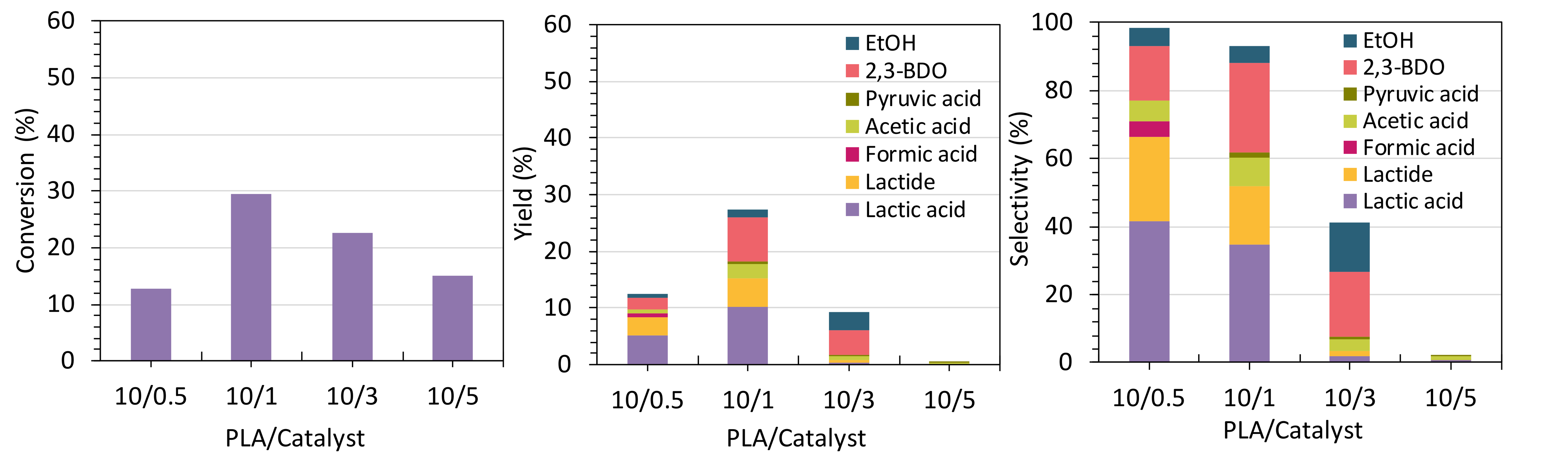
Novel Titanate (Hydroxy)oxide TiO(OH)

Light intensity optimization



✓The highest product yield was achieved with 100 % light intensity. However, highest selectivity to photo-upcycling products is observed at 75 % light intensity.

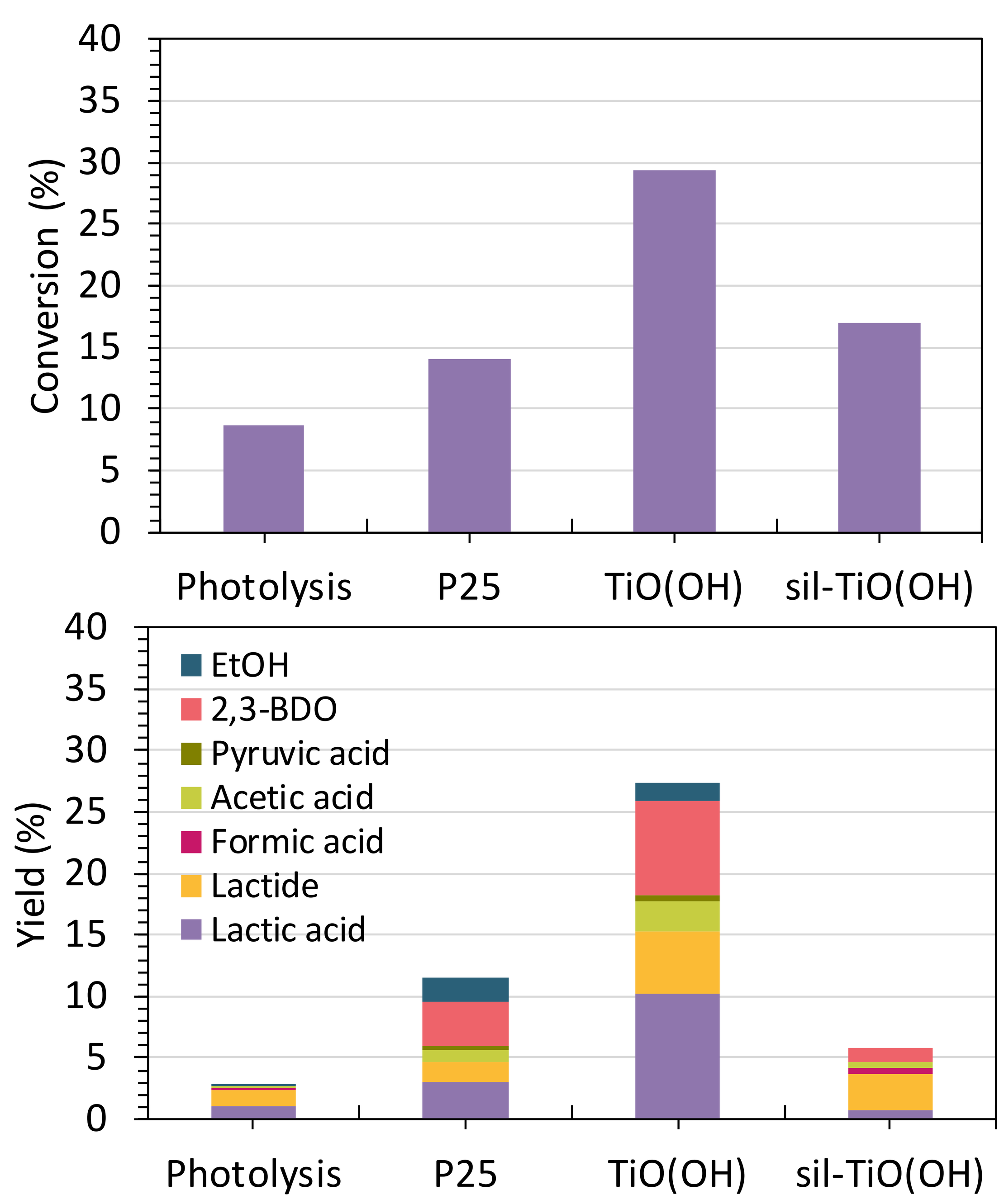
PLA:Catalyst moral ratio optimization



✓The highest PLA conversion and product yield was achieved with 10/1 PLA:Catalyst moral ratio optimization.

✓An increase in catalyst amount resulted in lower selectivity.

Comparison of photocatalytic performance



Remained PLA characterization by GPC:

Sample	Mw (g/mol)	Mn (g/mol)	PDI
$PLA_{initial}$	17093	**263612**	1,54
$PLA_{after\ P25}$	9346	**13124**	1,4
$PLA_{after\ US\text{-}TiO(OH)}$	10400	**4661**	**2,2**

Acknowledgments

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Greece 2.0 NATIONAL RECOVERY AND RESILIENCE PLAN

H.F.R.I. Hellenic Foundation for Research & Innovation

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