Hanze
University of Applied Sciences
Groningen

More with PHA’s, adventures at the Hanze.

André Heeres, Janneke Krooneman, Hanze University of Applied Sciences,
April 2023

share your talent.
move the world.

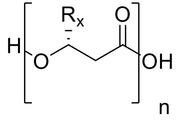
PHA : Market pull

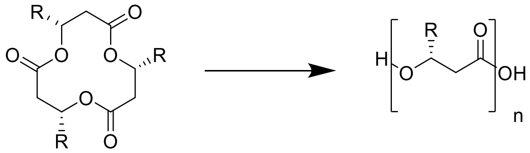
- Increase the attractiveness of PHA’s
- Different market segments

PHA : Hanze University of Applied Sciences

sample_id	Source	Label	percentage 3HB	percentage 4HB	percentage PHBV/H	Mp	Mn	Mw	Tm_C
S1	Mirel	PHB M4100	66,7	33	0,3	38798	21158	87428	168,5
S2	Natureplast	PHI-002	96,8	0,0	3,2	135455	86819	187892	162,8
s3	Enmat	Enmat Y1000p	98,8	0,0	1,2	168572	81881	197731	168,8
s4	Mirel	PHB M2100	92,2	5,8	1,9	101076	75598	166639	169,56
s5		PHB J330	84,5	15,5	0,0	40734	20281	45371	166,9
s6	Kaneka	X131A	93,3	0,0	6,7	266349	137538	311120	146,8
s7	Kaneka	X151A	86,5		13,5	192843	105108	247139	140,1
s8		YK100831-1	63,0	35,8	1,2	45205	34446	94437	170,4
s9		Ecomann	73,7	21,1	5,2	77837	64853	95294	143,5
s10		yk100831-2	61,6	35,3	3,1	45205	34446	94437	169,7
s11		Anox Kaldnes	100,0	0,0	0,0	nd	nd	nd	174,5
s12	Kaneka	X531N	90,4	0,0	9,6	138380	88657	188430	145,9
s14	Danimer	a01210	95,0	0,0	5,0	233796	131572	344503	145,43
s15	Danimer	a01235	99,8	0,0	0,2	342848	167312	478248	163,57

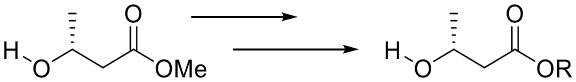
- Analysis, properties/applications





R = Me

- Chemical Recycling



- Ketones bodies

- Medical devices

- Production and sustainable down stream processing

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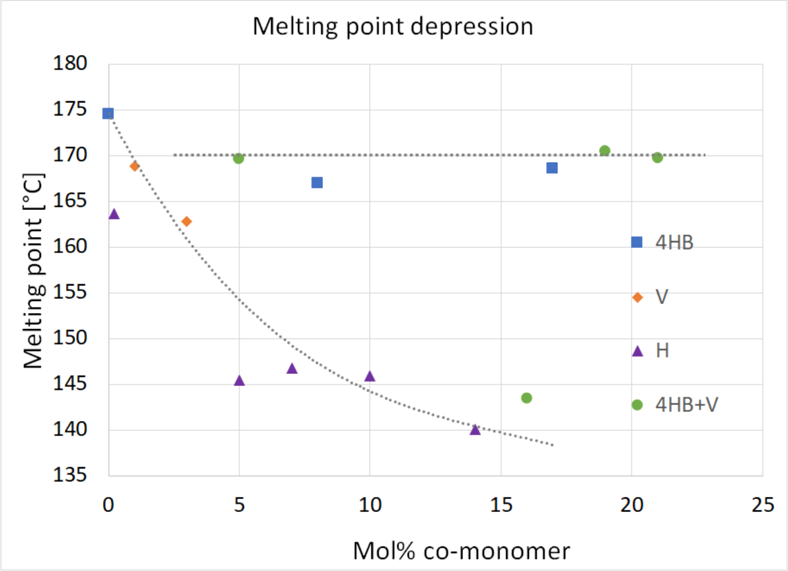
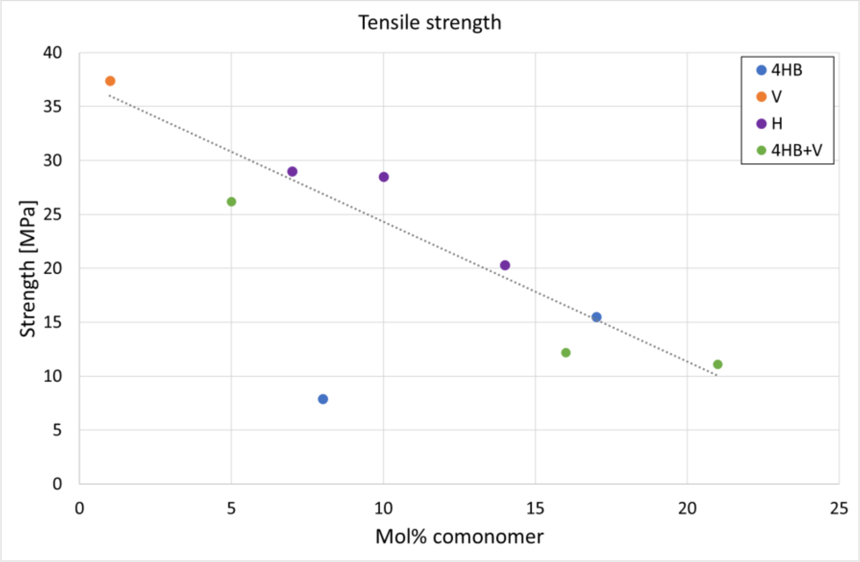
Enhancing properties of PHA

- The biochemical approach: Fit-for-purpose PHA





Enhancing properties of PHA

SENBIS
POLYMER INNOVATIONS

- The biochemical approach: Fit-for-purpose PHA

- Database

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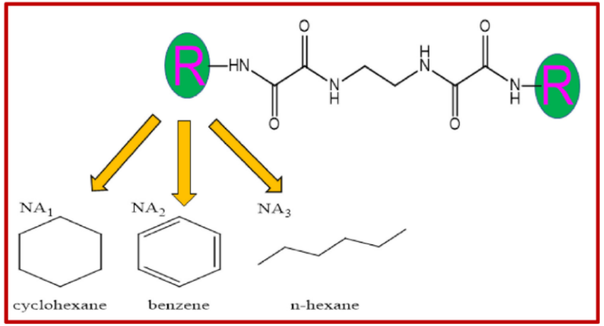
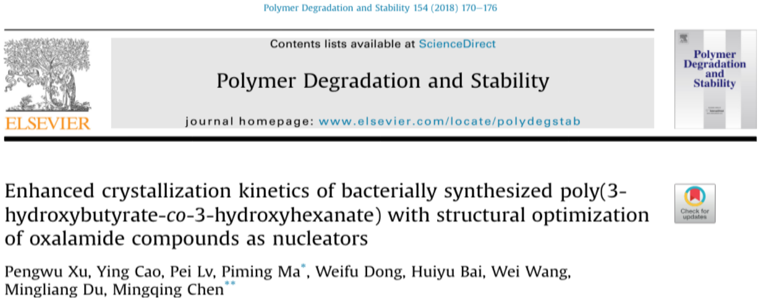
- Demand-driven fermentation

Enhancing the properties of PHA

- The “mechanical/additive” approach
- An example: Hanze nucleators





Polymer Degradation and Stability 154 (2018) 170–176

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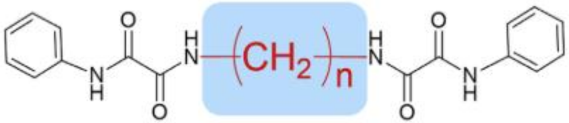
Polymer Degradation and Stability

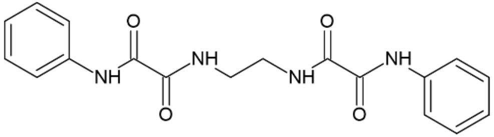
journal homepage: www.elsevier.com/locate/polydegstab

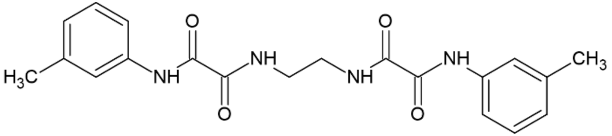
Enhanced crystallization kinetics of bacterially synthesized poly(3-hydroxybutyrate-*co*-3-hydroxyhexanate) with structural optimization of oxalamide compounds as nucleators

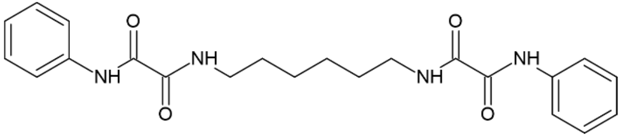
Pengwu Xu, Ying Cao, Pei Lv, Piming Ma*, Weifu Dong, Huiyu Bai, Wei Wang, Mingliang Du, Mingqing Chen**

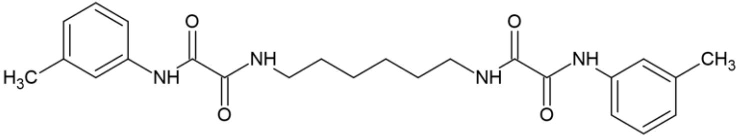


Nucleating agents prepared





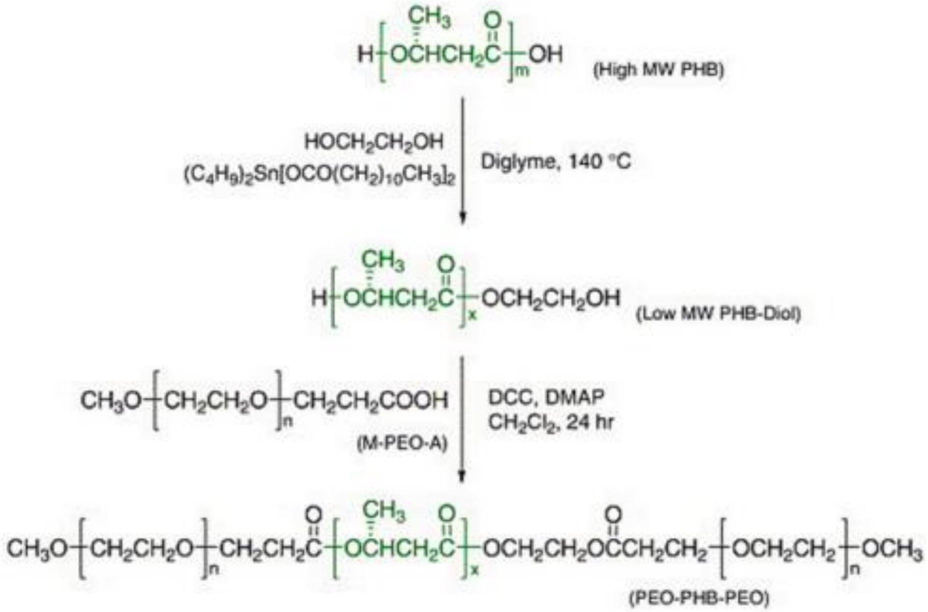




- Screening in progress (DSC)

Enhancing the properties of PHA

- The chemical approach

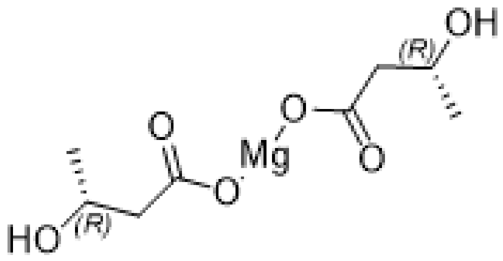


- Biodegradable fragments

Fine chemicals: Magnesium (R)-3-hydroxybutyrate

Magnesium supplements

- Treat magnesium deficiency
- Improve cognitive impairment/enhancement
- Positively influence sleep and calmness



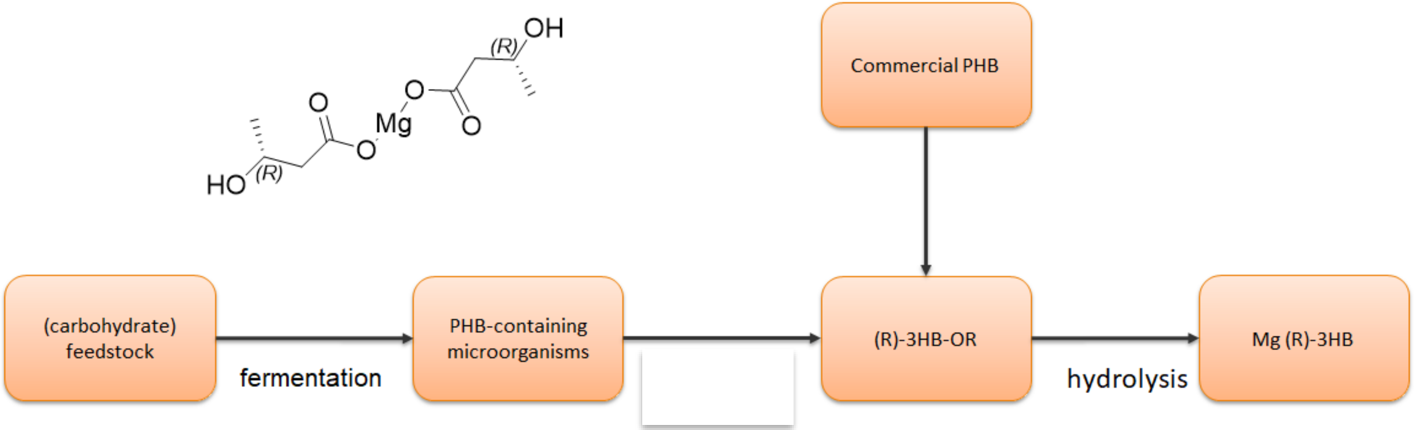
Market needs

- Better bioavailablity, including brain
- Dual/multiple ligands (bioactivity organic acid)

Restrictions

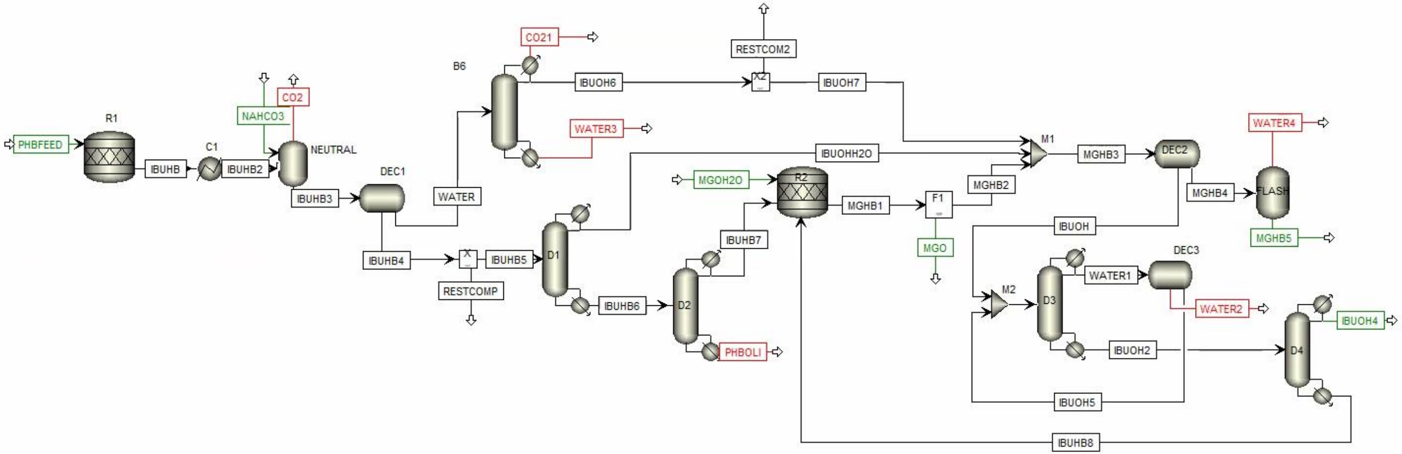
- Stable, non-toxic, prepared via an economically and ecologically attractive route

Synthesis



- Feedstock: Carbohydrates/end-of-life PHB
- Fermentative/Chemical proces (green solvents)
- Extraction microorganisms, preventing crotonate formation (patent pending)
- TRL 4-5, kg amounts in progress

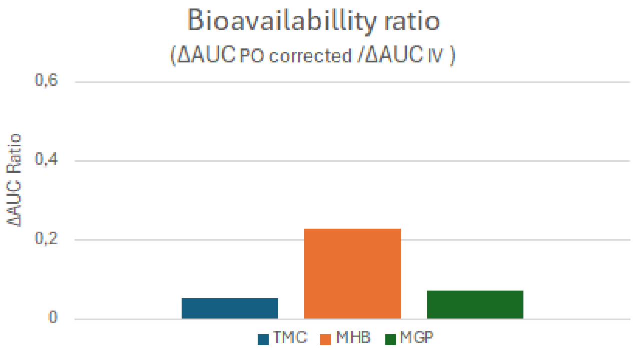
Techno-economic evaluation

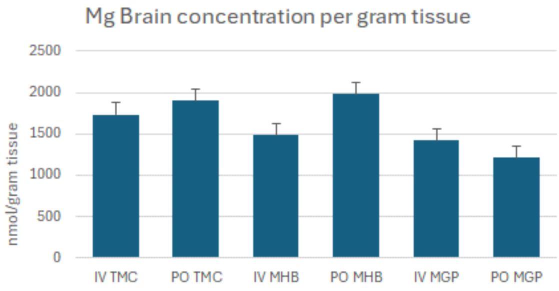


- Preliminary proces design
- Optimization
- Aspen software
- Calculation cost-price (1 kton/year)

In vivo studies (pilot)

Quantall

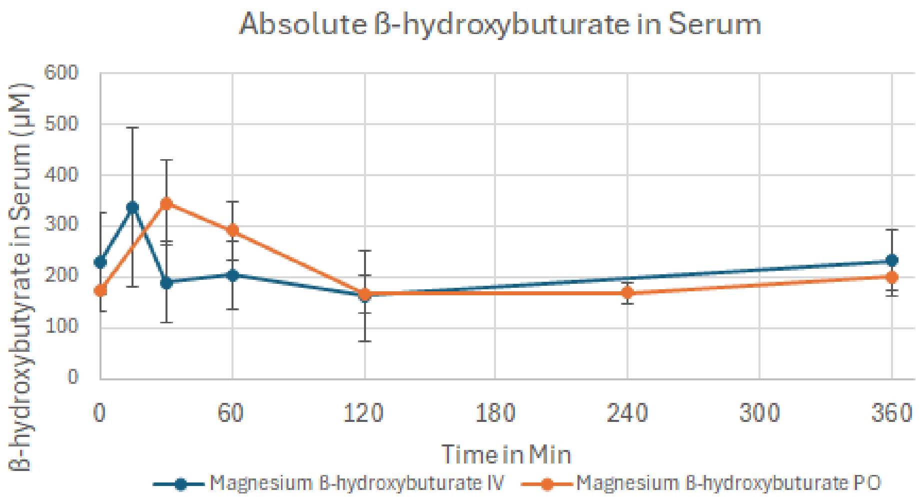




- Benchmarking against magnesium citrate (TMC) and magnesium glycerophosphate (MGP)
- Higher bioavailabity
- Better brain penetration (oral)

In vivo studies

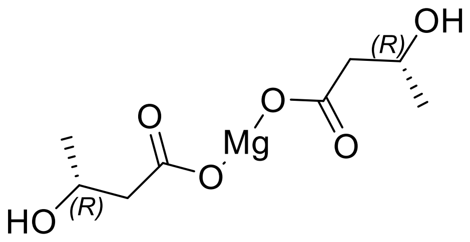
Quantall



- Fast clearance observed of (R)-3-hydroxybutyrate
- Energy (brain?), other roles?

Perspectives

- Health benefits (magnesium deficiency, cognition, anti-stress, etc.)
- Attractive route for preparation
- Multiple ligand (synergism/complementation magnesium and 3-hydroxybutyrate (= Mg plus)),
- High(er) bioavailability
- Natural compound
- Enantiomerically pure
- Western producer



Conclusions

- The market for PHA is still in its infancy!

André Heeres — Hanzehogeschool Groningen

a.heeres@pl.hanze.nl