bioplarch

Starch based bioplastic as a construction material

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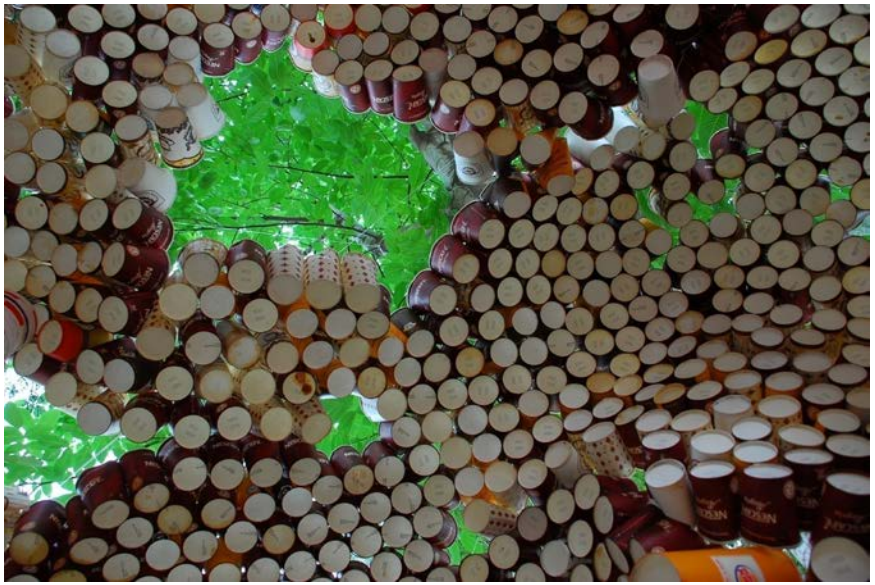
Future Architecture Platform

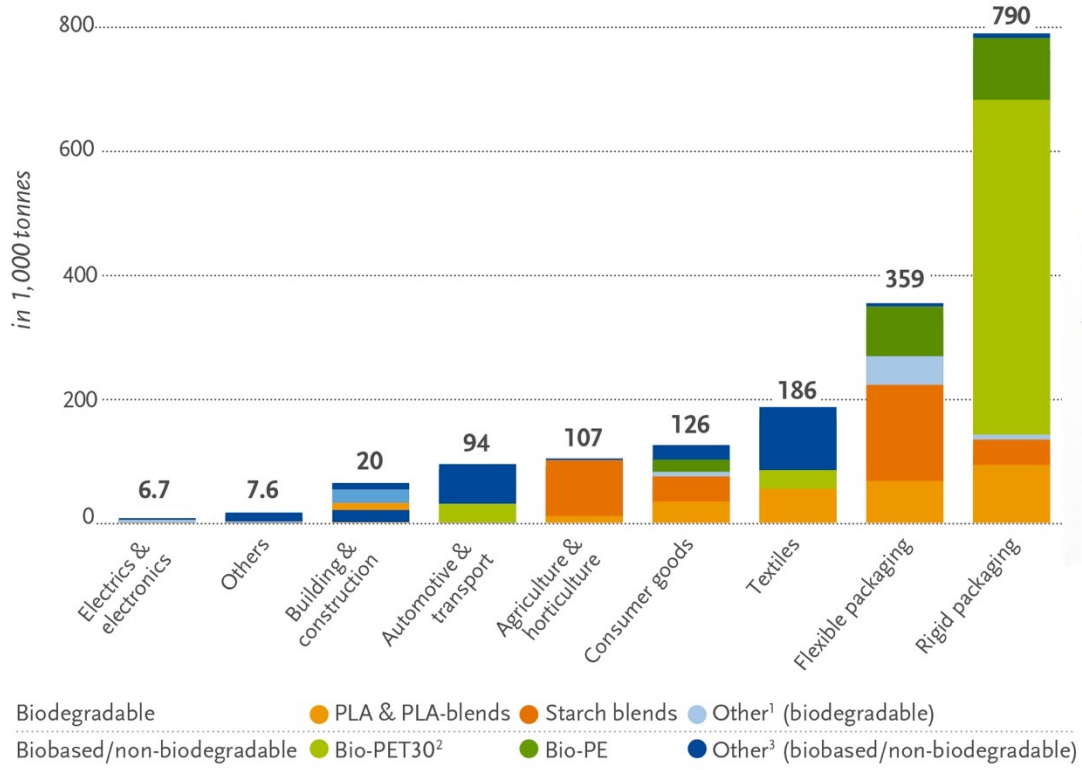


Aim

- Experimentation of material/immaterial
- Biodegradable eco-friendly material in interior design/as facade element
- An alternative to cement in conrete
  Replace/decrease cement in concrete
  Provide a matrix for carbon, glass and aramid fibers

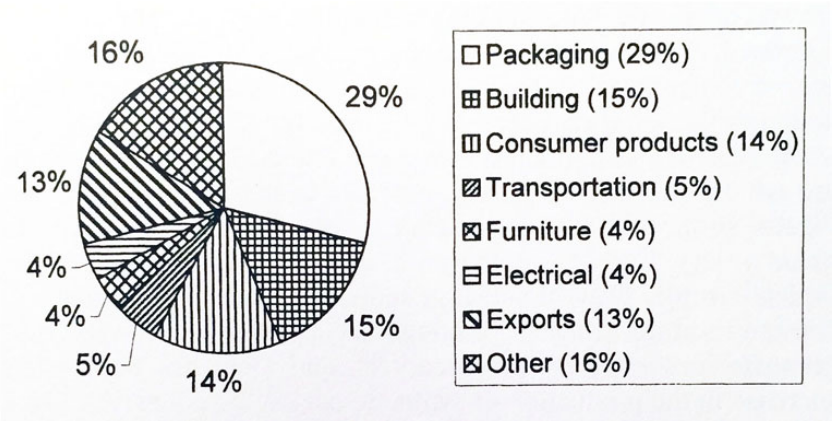
Bioplastic statistics

Global production capacities of bioplastics 2014 (by market segment)



¹Contains regenerated cellulose and biodegradable cellulose ester; ²Biobased content amounts to 30%; ³Contains durable starch blends, Bio-PC, Bio-TPE, Bio-PUR (except thermosets), Bio-PA, PTT

Source: European Bioplastics, Institute for Bioplastics and Biocomposites, nova-Institute (2015).
More information: ***www.bio-based.eu/markets*** *and* ***www.downloads.ifbb-hannover.de***



Some of the active market areas for bioplastics

PLA (polylactic acid, corn starch) cup

PLA bioplastic plastic bag

PLA bioplastic 3D print filament

Bioplastic from
banana peels (Elif Bilgin, 2014)

Shrimp shell bioplastic
(Harvard University, 2014)

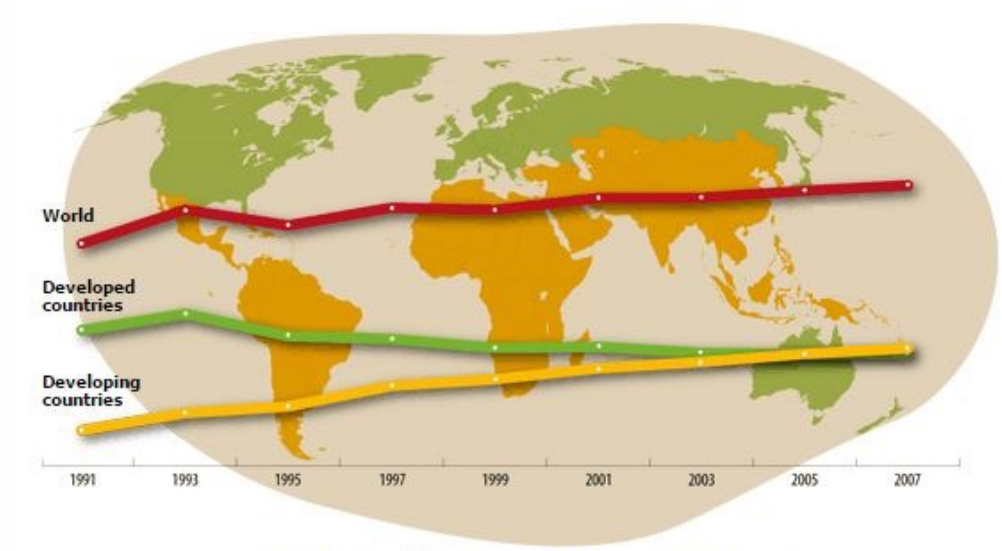
Cellulose asetate bioplastic
package

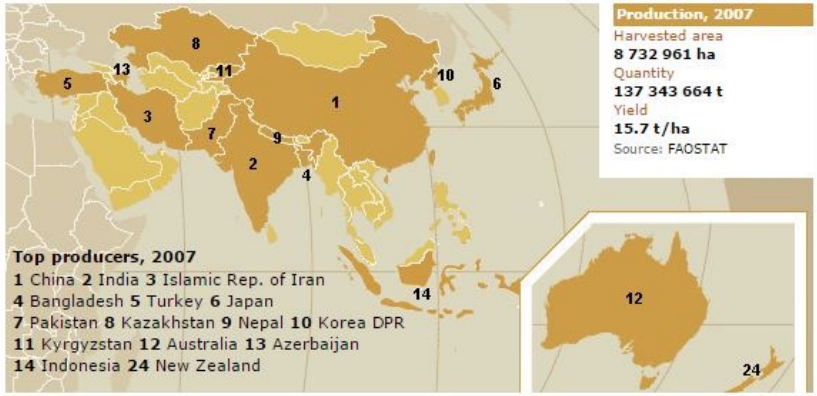
Soybean / hemp car

Henry Ford, World’s first plastic car, 1941

Bioplastic from potato… Sustainable? Local? Economical?

World potato statistics





World potato production, 1991-2007

	1991	1993	1995	1997	1999	2001	2003	2005	2007
Countries	million tonnes								
Developed	183.13	199.31	177.47	174.63	165.93	166.93	160.97	159.97	159.89
Developing	84.86	101.95	108.50	128.72	135.15	145.92	152.11	160.01	165.41
WORLD	267.99	301.26	285.97	303.35	301.08	312.85	313.08	319.98	325.30

Source: FAOSTAT

Half-Acre / Half-Life
Domino's Farms, Ann Arbor MI, 2012

This project tested a short-lived architecture that transforms biodegradable, plant-derived materials into a spatial enclosure while anticipating their disappearance. A temporary landscape installation composed entirely of bioplastic, which was cooked and installed on an educational farm over a November weekend. *Half-Acre/Half-Life* was a live field experiment within the broader research project *(De)composing Territory*, which investigates a range of architectural possibilities for various recipes of homemade bioplastics, using ingredients found in the kitchen, including sugar, plant starches, vegetable glycerin, vinegar, and water.

Installation Team: Meredith Miller, Peter Halquist, Nathan Oppenheim, Lizzie Krasner, James Graham, Laurin Aman, Delle Guarnero

Thanks to John Petz of Domino's Farms and Charlie Frank of Zingerman's Candy Manufactory

Meredith Miller, Half-Acre/Half-Life, 2012

BIO BRICK

1.7 Kg of potatoes → 350 grams of starch → 1 brick of bioplastic 1000 cm³

This experiment is an attempt to understand how much initial resources are needed to make a certain volume of bioplastic.
350 grams have been used to make a 1000 cm ³ brick of bioplastic.
To produce 350 grams of starch 1.75 kg of potatoes are needed.
The mixture for the brick has been first heated in a pot. Then poured in a rectangular mould and finally placed in an oven where it reached a solid state.
The brick was then left to dry at room temperature.

Marilu Valente, 2015

Juliette Pepin, 2013

Johan Viladrich, 2014

Arboskin Bioplastic Pavillion, ITKE, Stuttgart, 2013

BIOPLASTIC = Biopolymer(s) + plasticizer(s)+ other additive(s)

(Stevens, 2002, 105)

Gelatin, starch, agar
3g=1 tsp

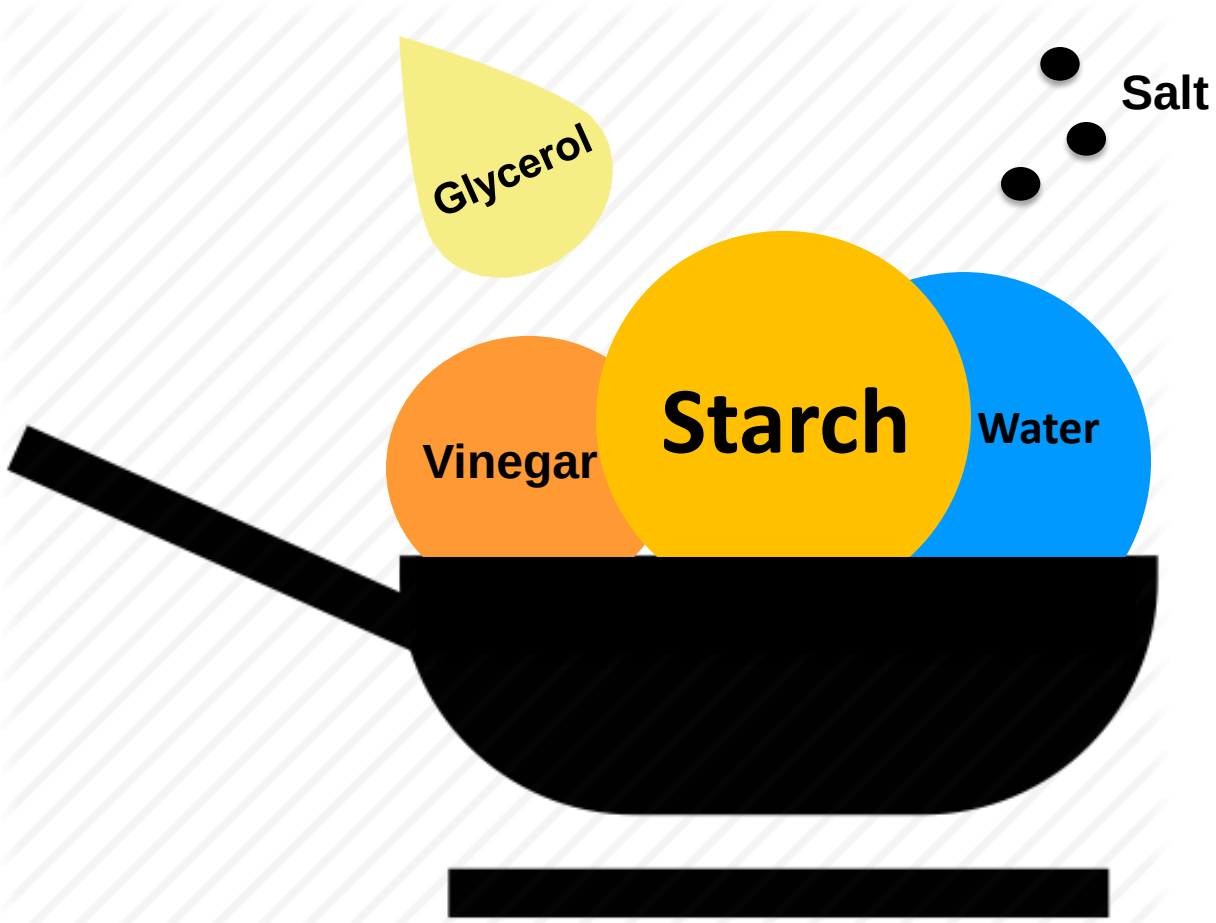
Glycerol
3g= 24 ml=1/2 tsp
Sorbitol

Potato starch

Vegetable glycerin

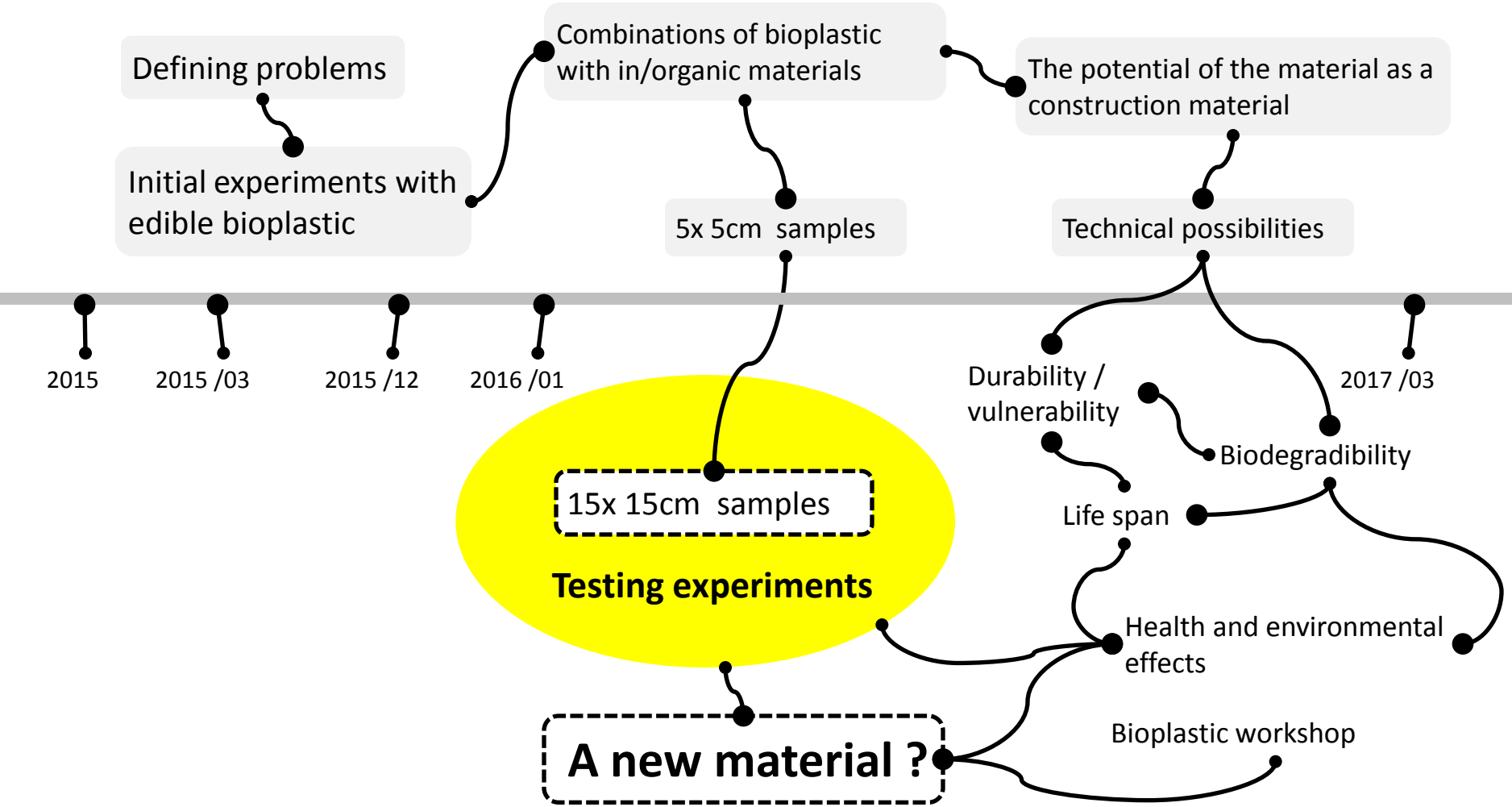
Apple vinegar

Basic Ingredients of Bioplastic



Heating: Oven / hot plate, just below boiling 95° C.

Process planning



Initial experiments on edible bioplastic

Initial experiments on bioplastic

Initial experiments on bioplastic

Initial experiments on bioplastic

Initial experiments on bioplastic

Cooking

Cooking

Sieved: 0,63 (ASTM)

Experiment 1: Cooking, molding and open-air drying




Bioplastic 50%, aggregate (0-4mm) 50%

Dimension: 15 x 15 x 15 cm

Experiment 1: Cooking, molding and open-air drying

Bioplastic 50 %, aggregate 50 %

Dimension: 15 x 15 x 15 cm

Experiment 2: Cooking, molding and drying in the oven




Bioplastic 50%

Mix 50%

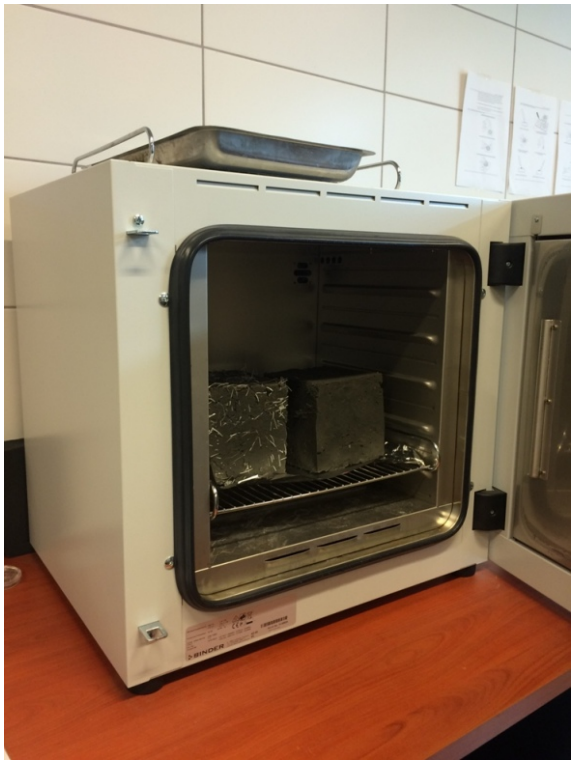
Dimension: 15 x 15 x 15 cm

40 % silica fume

60 % Aggregate

Molding

Experiment 2: Cooking, molding and drying in the oven

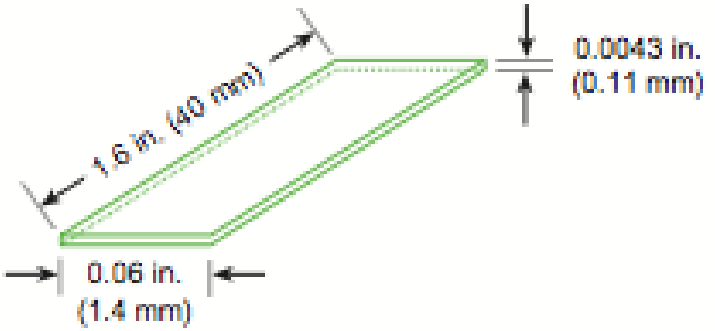


Bioplastic 50 %

Mix 50 % : 40 % silica fume 60 % Aggregate

Dimension: 15 x 15 x 15 cm

Experiment 2: Cooking, molding and drying in the oven

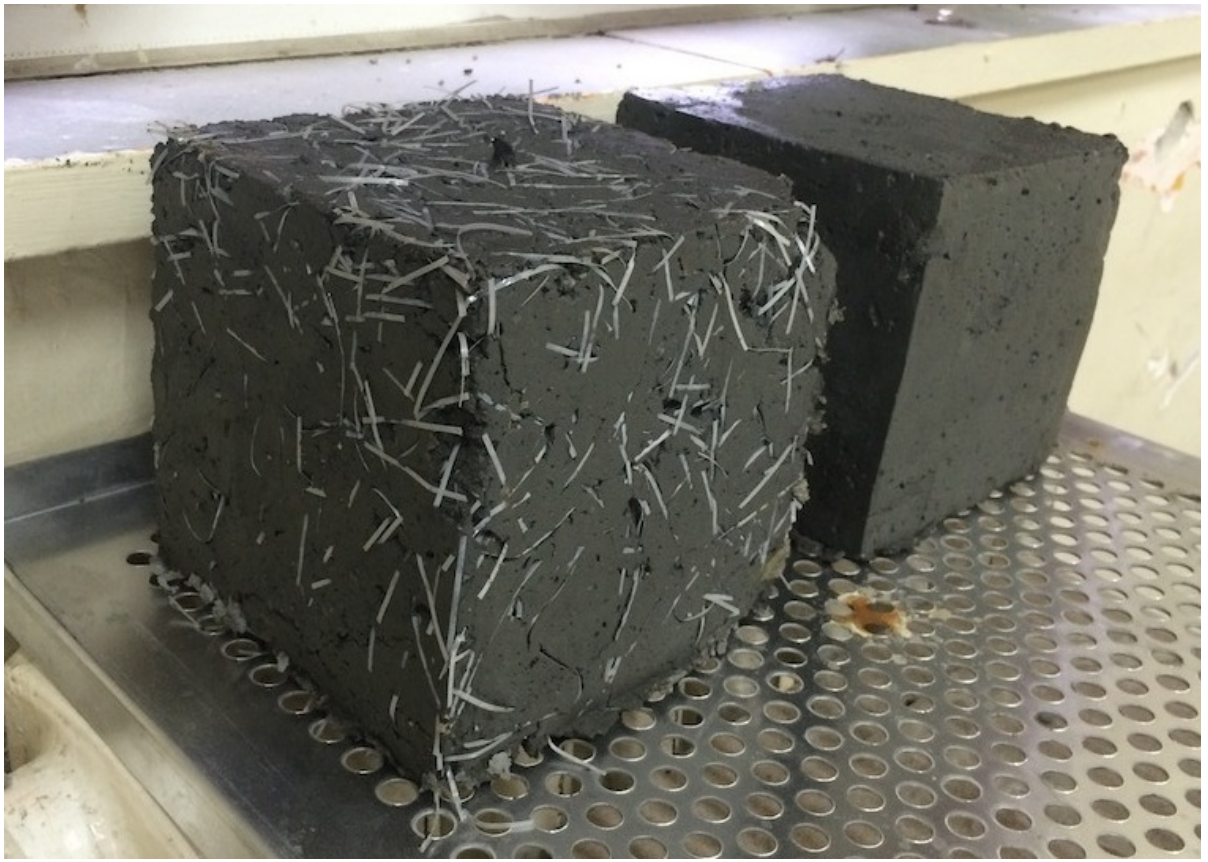


Bioplastic 50 %,

Mix: 50 % (aggregate 59 %, 40 % silica fume, 1% polyolefin fibre)

Dimension: 15 x 15 x 15 cm

Experiment 2: Cooking, molding anddrying in the oven

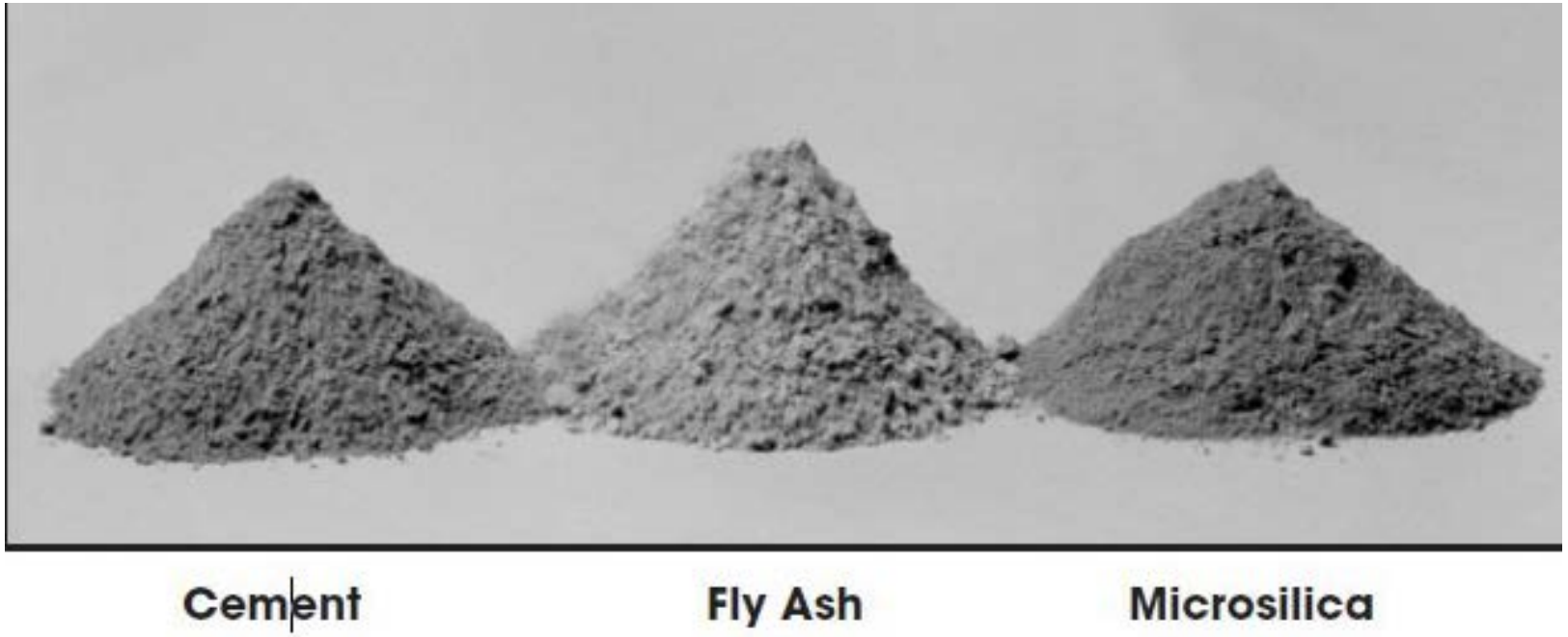


Bioplastic 50%,

Mix: 50% (aggregate 59 %, 40 % silica fume, 1 % polyolefin fibre)

Dimension: 15 x 15 x 15 cm

Fly ash and silica fume



An alternative to decrease landfill? Healthy as a construction material?

Fly ash use

Landfill

Toxic to ground water?

Testing Experiments

			Amount / type									Environment charact.		Cooking					Drying type			Dimensions					Material Characteristics										
No	Date	Time	Starch (gr)	Water (ml)	Glycerol	Vinegar	Salt	Other Additive				Temperature °C	Humidity	Start time	Finish time	Other material	Adding time	Intervention after cooking	Drying type	Drying start time	Drying finish time	Dimension after cooking (cm)	Number of mold	Other mold dimension (cm)	Number of other mold	Dimension after drying	Weight	Hardness	Transparency	Elasticity	Resistance to	Sound	Surface Characteristic	Odor	Color	Decay
			Amou	Characteristics				Material	Charact.	Intervention	Amount (gr)							Charact.	Time																	
1	08.02.2016	16:30	2430	Potato	9729	1215	1215	100				19		17:30	18:30					Heating	19:00		15x15x15	5												
2	09.02.2016	16:30	12	Corn	48	4,5	4,5	1				19		15:00	15:08			Between two gla		Heating	15:20		18x10z1	1												
3	09.02.2016	16:30	1215	Potato	2430	607,5	607,5	10	Aggregate	0-4mm	Sieved (0,63)	4660	19		18:40	18:50	Aggregate	18:45	Mixer	5	Heating	19:00		15x15x15	1	25x40,5x2,5	1									
4	10.02.2016	17:46	24	Potato	96	9	9	2					19		17:46	17:52					Open a	17:55		15x15x15	1												
5	10.02.2016	18:08	48	Potato	192	18	18	5					19		18:08	18:16	Synthetic	18:13			Open a	18:15														
6	11.02.2016	15:04	1215	Potato	3601	607,5	607,5	70	Aggregate	0-4mm	Sieved (0,63)	2330	19		15:04			15:08			Heating	16:00 (+ 1 day)		15x15x15	1												
									Synthetic macro fibre reinf.	90/40		32	19					15:22						15x15x15	1												

American Society for Testing and Materials (ASTM)

Glass temperature
Tensile strength
Indentation hardness
Elongation
Loss of volatile components
Barrier to oxygen
Barrier to moisture
Oil resistance
Ease of marring
Fold resilience
Tear resistance

Bioplastics… A paradigm shift?

- An alternative biodegradable material in architecture…
- An alternative to replace/decrease cement in concrete and provide a matrix for carbon, glass and aramid fibers…
- Depending on non- petroleum-based and sustainable feed stocks…
- Edible temporary/permanent spaces…
- Interdisciplinary / trandisciplinary research…


THANK YOU

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