Sherpack Final Workshop

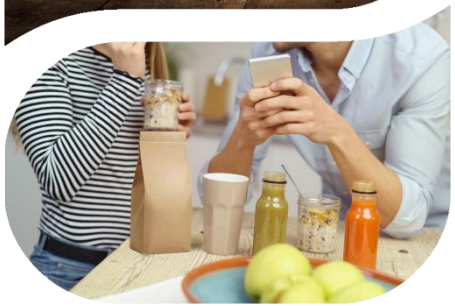


Polysaccharide grid for improved stiffness and grip

Richard Thalhofer | Cargill and Jérémie Viguié | CTP

sherpack





Polysaccharide grid for improved stiffness

Richard Thalhofer (Cargill), Jérémie Viguié (CTP)

Online-Workshop, October 7th, 2020

Bio-based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation

BBI JU

Cargill at a glance

Cargill® Helping the world *thrive*

Our purpose is to nourish the world in a safe, responsible and sustainable way.

At a glance

160,000 employees	Working in 70 countries	More than 150 years of experience

A trusted partner for food, agriculture, financial and industrial customers in more than 125 countries.



Agriculture



Food



Animal nutrition and protein

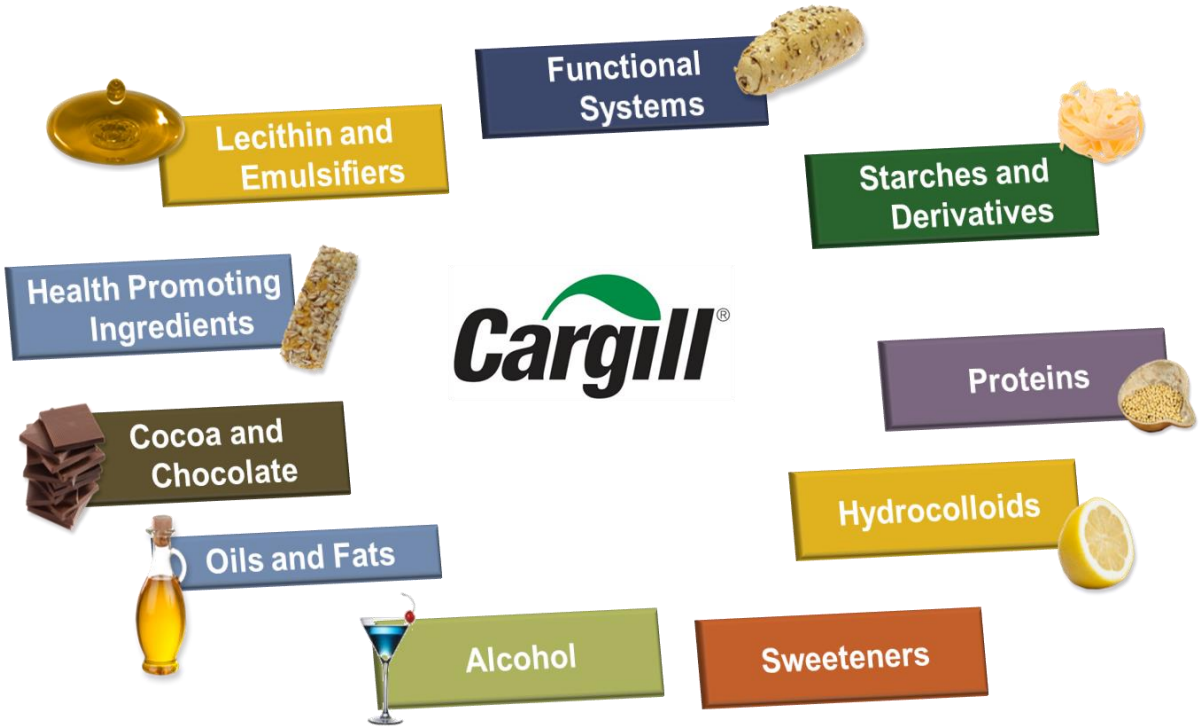


Financial and industrial

Fiscal 2019 adjusted operating earnings: $2.82 billion

Cargill reports financial results in accordance with U.S. generally accepted accounting principles (GAAP).
The company also reports adjusted operating earnings, a non-GAAP financial measure that provides additional insight into the underlying financial performance of the company's ongoing operations.

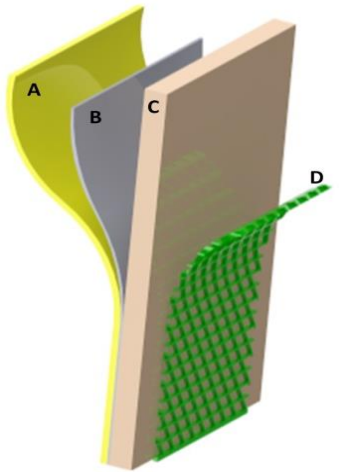
Cargill offers



Objective

- Innovative structured polysaccharides-based material for recyclable and biodegradable flexible packaging
- To reduce basis weight of self-standing flexible packaging while improving bending stiffness
- By printing a starch-based grid on the paper surface

KPI	Market Reference = mPET/LDPE	POC 1: Paper + MFC+ PLA-blend	POC 2: POC 1 + Grid	Δ POC 1/2
Grammage (g/m²)	88	83	75	**↓10%**
Thickness (µm)	87	72	77	↑ 7%
Bending stiffness (mN.m)	**0,05**	**0,07**	**0,11**	**↑ 57%**

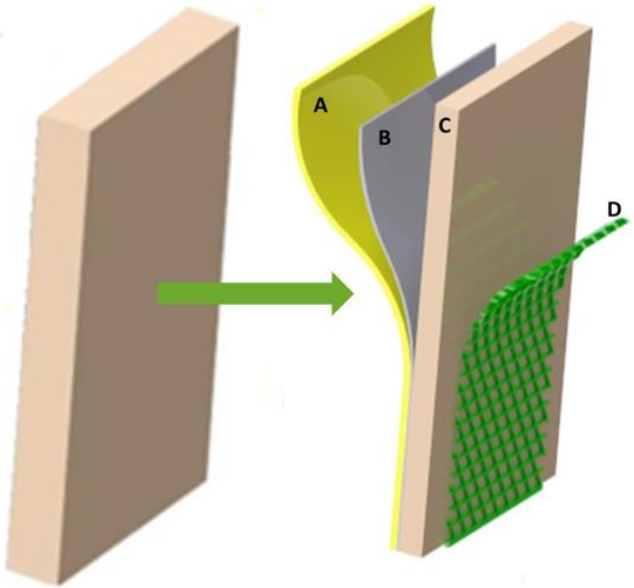


Concept

AHLSTROM MUNKSJÖ

Cargill

Borregaard



ctp centre technique du papier

Cargill

Borregaard

Paper substrate specification

Printed reinforcement grid

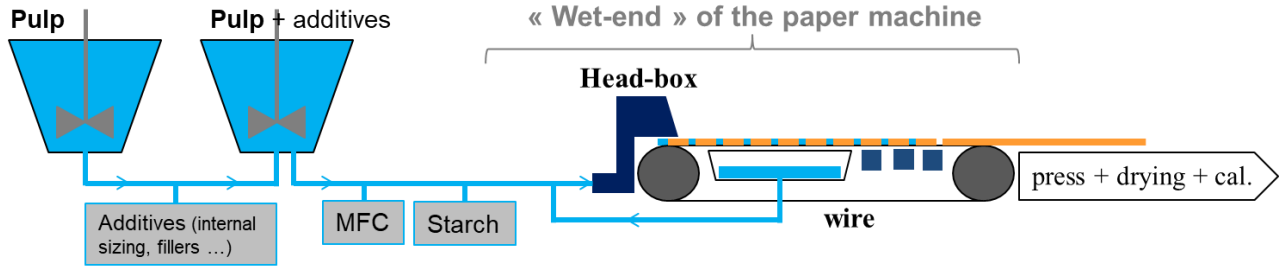
Paper substrate specification

- **Objective:**

  Specification of paper substrate with reduced basis weight, but with suitable mechanical properties for packaging applications.

- **Activities:**

  Investigation of effects from bio-based additives (cationic starch and/or MFC) on the mechanical properties of papers, produced on a pilot paper machine.

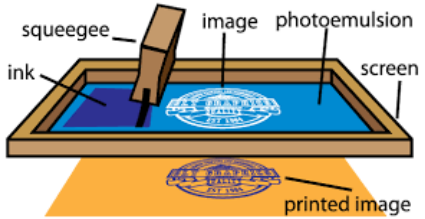


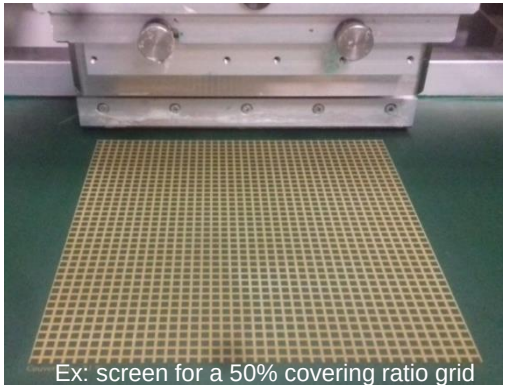
Paper substrate specification

- **Outcomes:**
  - "Bio-additives" improved some mechanical properties, while reducing basis weight (60 → 45 g/m²):
    - Internal cohesion, elongation, tensile strength
  - But basis weight reduction was **not** counterbalanced by additives with regards to:
    - Tear resistance and stiffness

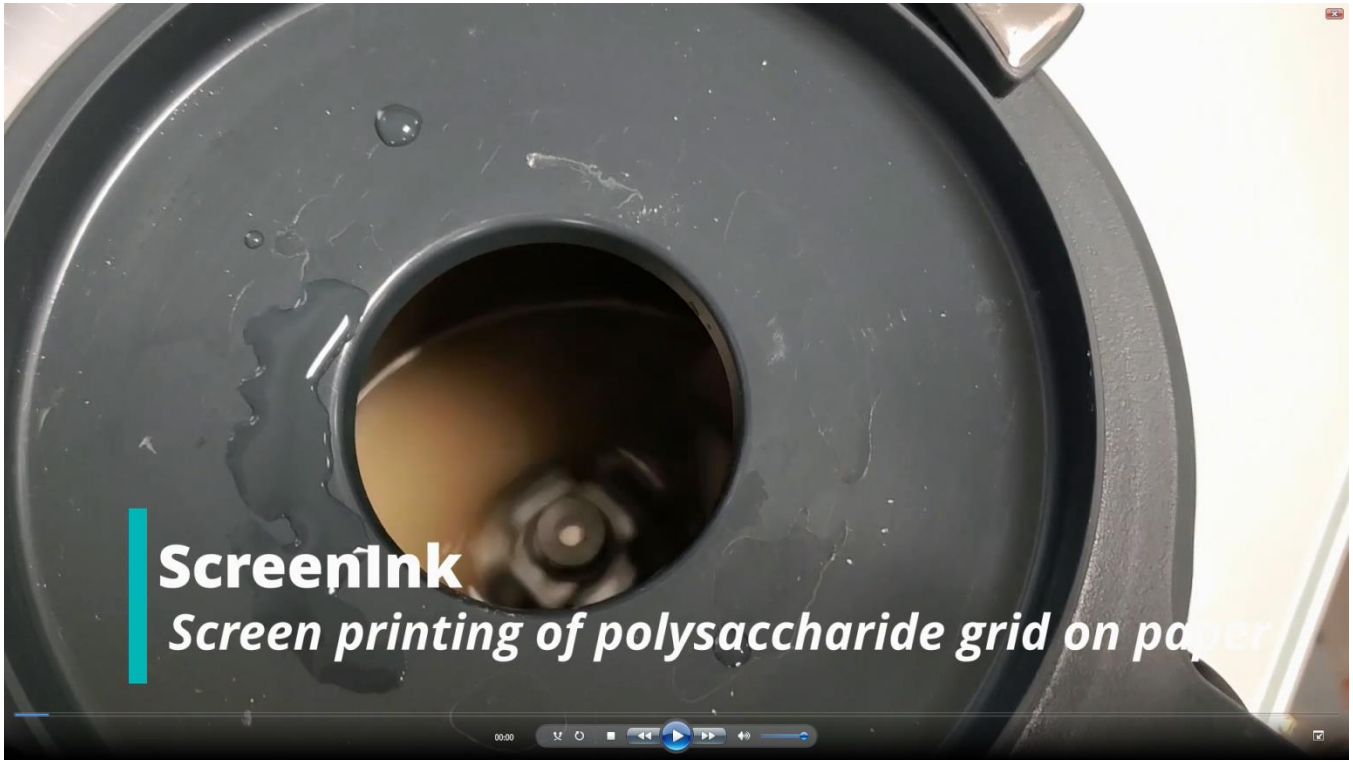
Printed reinforcement grid

- **Printing of starch-grid on the paper surface**
  - Screen printing
    - Widely-used industrial process
  - Starch formulation
    - Modified starch formulation (Cargill)
  - Paper substrate
    - Gerstar paper (Alhstrom Munksjo)
  - Grid
    - Orthogonal
      - Covering ratio: 20% → 75%
    - Specific patterns
      - Honeycomb
      - Re-entrant
      - Sinusoidal



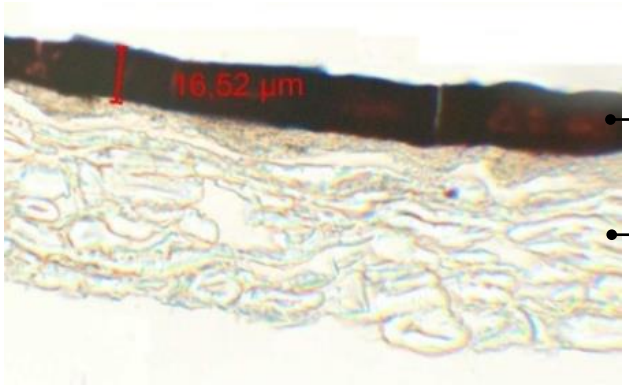

Ex: screen for a 50% covering ratio grid

Printed reinforcement grid

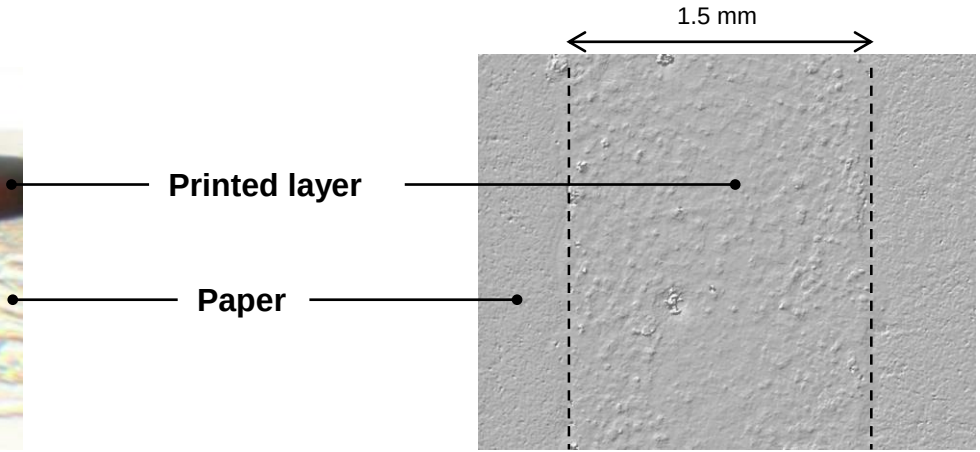


Results

- **Printed paper features**
  - Suitable printing



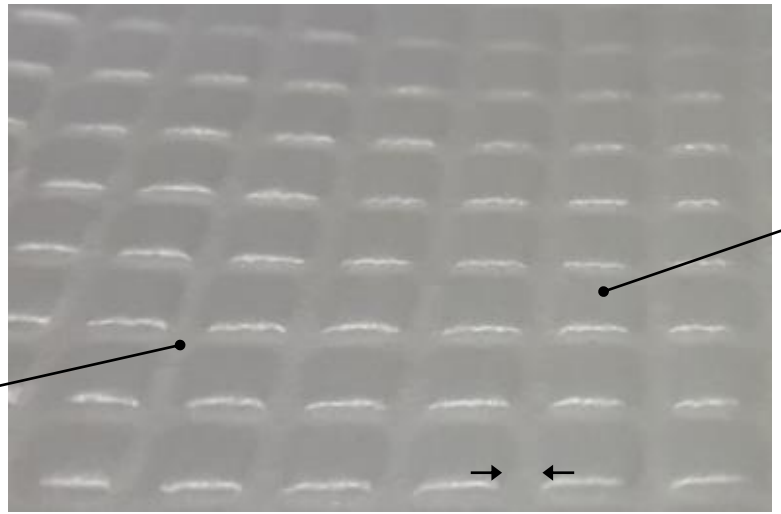
Printed paper cross section
(after an iodine staining)



Top view

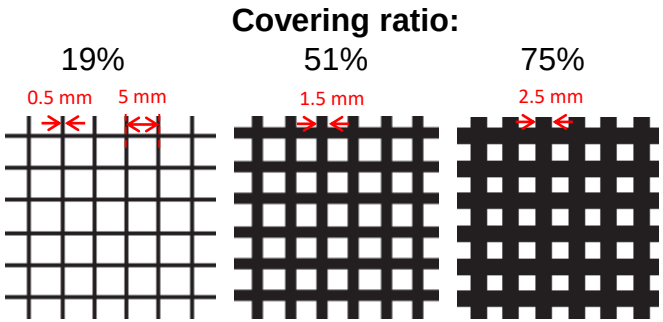
Results

- **Printed paper features**
  - Orthogonal grid
    - Unexpected 3D topography ➔ Printed lines form « valleys »

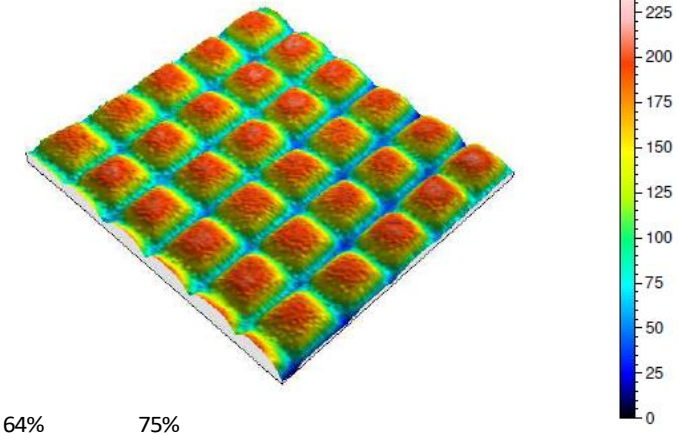


Results

- **Printed paper features**
  - Orthogonal grid



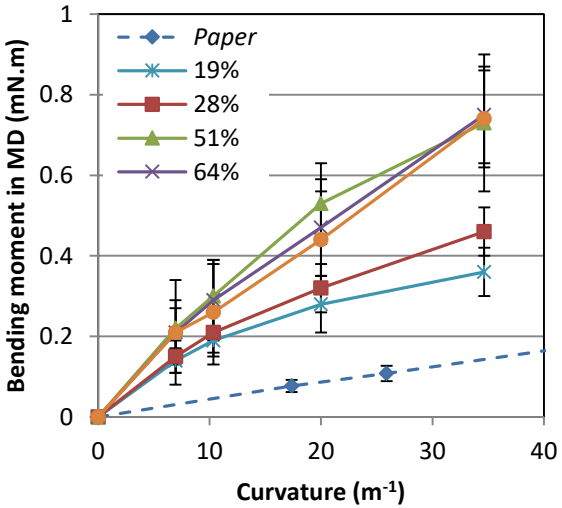
By topographic measurement (3D Map® - CTP)

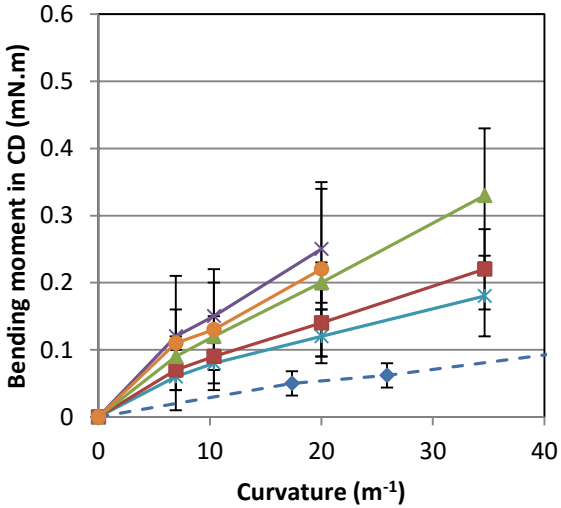


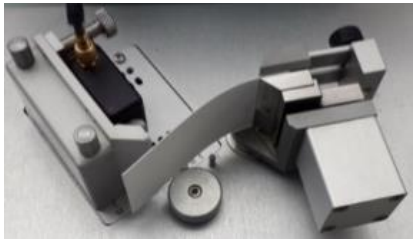
	Paper	19%	28%	51%	64%	75%
Basis weight (g/m²)	58.9 ± 0.6	64.9 ± 1.2	67.2 ± 0.7	72.6 ± 2.8	75.2 ± 0.8	77.7 ± 1.3
Thickness (µm)	58 ± 2	141 ± 14	190 ± 19	247 ± 32	256 ± 17	240 ± 15

Results

- **Orthogonal grid**
  - Mechanical performance as a function of covering ratio







Bending performance:
x2 at 28% covering ratio
x3 at 50% covering ratio

Results

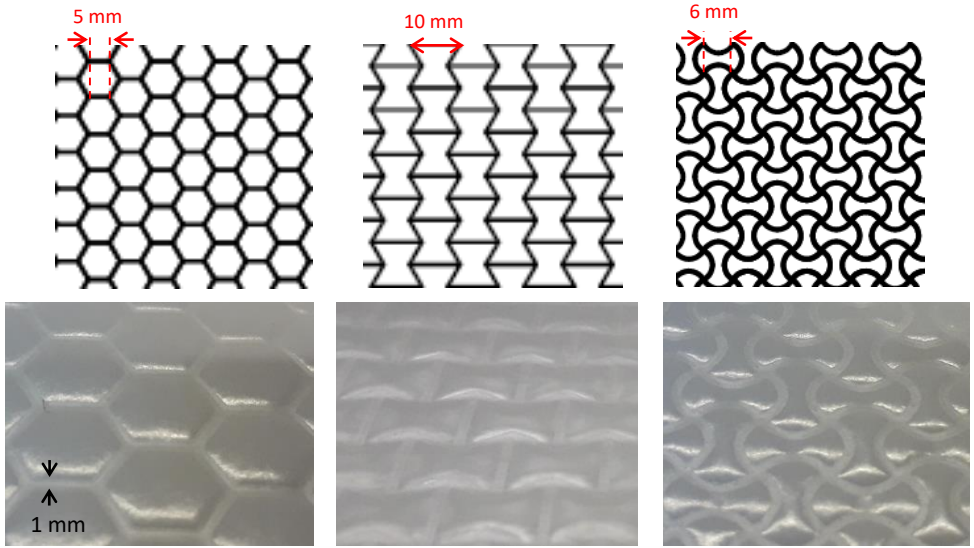
- **Orthogonal grid**
  - Mechanical performance as a function of covering ratio

		Paper	19%	28%	51%	64%	75%
Basis weight (g/m²)		58.9 ± 0.6	64.9 ± 1.2	67.2 ± 0.7	72.6 ± 2.8	75.2 ± 0.8	77.7 ± 1.3
Thickness (µm)		58 ± 2	141 ± 14	190 ± 19	247 ± 32	256 ± 17	240 ± 15
Tensile strength (kN/m)	*MD*	3.6 ± 0.1	3.6 ± 0.2	3.6 ± 0.2	3.6 ± 0.2	3.5 ± 0.1	3.4 ± 0.2
	CD	2.0 ± 0.1	2.0 ± 0.1	2.0 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1
Bending stiffness (mN.m)	*MD*	0.08 ± 0.02	0.35 ± 0.08	0.38 ± 0.10	0.55 ± 0.13	0.53 ± 0.15	0.53 ± 0.18
	CD	0.05 ± 0.02	0.15 ± 0.05	0.18 ± 0.07	0.22 ± 0.08	0.30 ± 0.10	0.28 ± 0.12

➔ Huge improvement of bending performance
➔ No significant evolution in tensile

Results

- **Specific grid patterns**
  - At iso-covering ratio (≈28%)



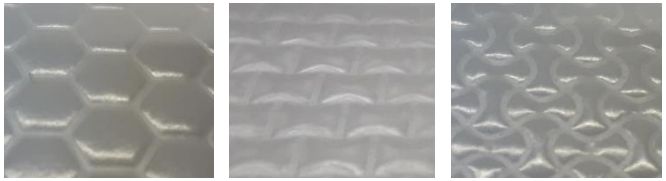
Honeycomb ***Re-entrant*** ***Sinusoidal***

➔ Suitable printing

➔ Well-defined patterns

Results

- **Specific grid patterns**
  - At iso-covering ratio (≈28%)

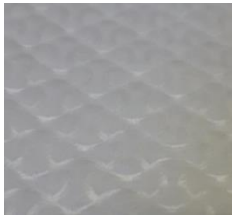


		Orthogonal	Honeycomb	Re-entrant	Sinusoidal
Basis weight (g/m²)		67.2 ± 0.7	64.6 ± 0.7	65.5 ± 0.7	67.6 ± 1.0
Thickness (µm)		190 ± 19	251 ± 13	249 ± 28	218 ± 10
Tensile strength (kN/m)	*MD*	3.6 ± 0.2	3.3 ± 0.4	3.6 ± 0.1	3.3 ± 0.3
	CD	2.0 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.0
Bending stiffness (MN.m)	*MD*	0.38 ± 0.10	0.33 ± 0.08	0.45 ± 0.13	0.45 ± 0.13
	CD	0.18 ± 0.08	0.28 ± 0.08	0.20 ± 0.03	0.28 ± 0.15

➔ Slightly greater improvement with sinusoidal pattern

Results

- **Other paper types**
  - Tracing paper
  - Blotting paper



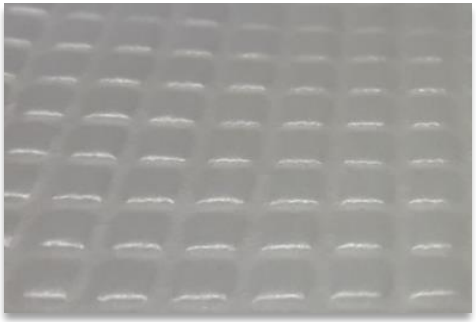


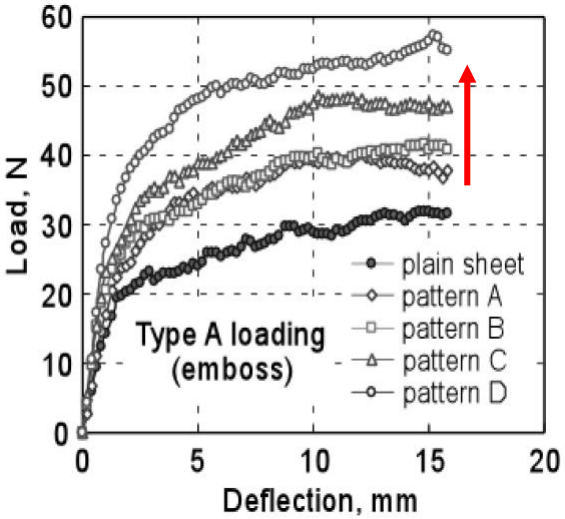
		Tracing paper		Blotting paper	
			Printed		*Printed*
Basis weight (g/m²)		70.4 ± 0.3	85.7 ± 0.7	69.6 ± 0.3	82.9 ± 0.3
Thickness (µm)		64 ± 1	298 ± 9	125 ± 2	193 ± 3
Tensile strength (kN/m)	*MD*	6.9 ± 0.3	6.2 ± 0.2	4.1 ± 0.2	4.3 ± 0.2
	CD	3.1 ± 0.1	3.2 ± 0.3	2.4 ± 0.1	2.4 ± 0.1
Bending stiffness (mN.m)	*MD*	0.30 ± 0.03	0.50 ± 0.05	0.18 ± 0.03	0.68 ± 0.15
	CD	0.15 ± 0.03	0.43 ± 0.05	0.08 ± 0.03	0.35 ± 0.10

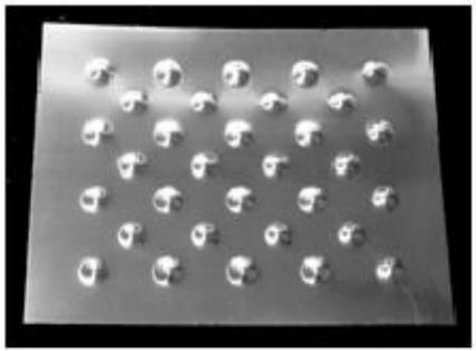
➔ Effective for denser or porous substrates

Understanding

- **Performance in bending largely higher than expected when adding a grid of 15 µm thickness**
  - Because of 3D topography formation
    - As when embossing a metal plate for example



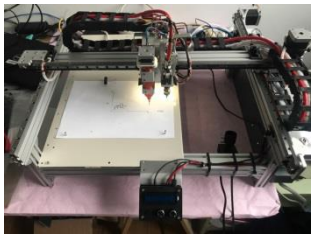




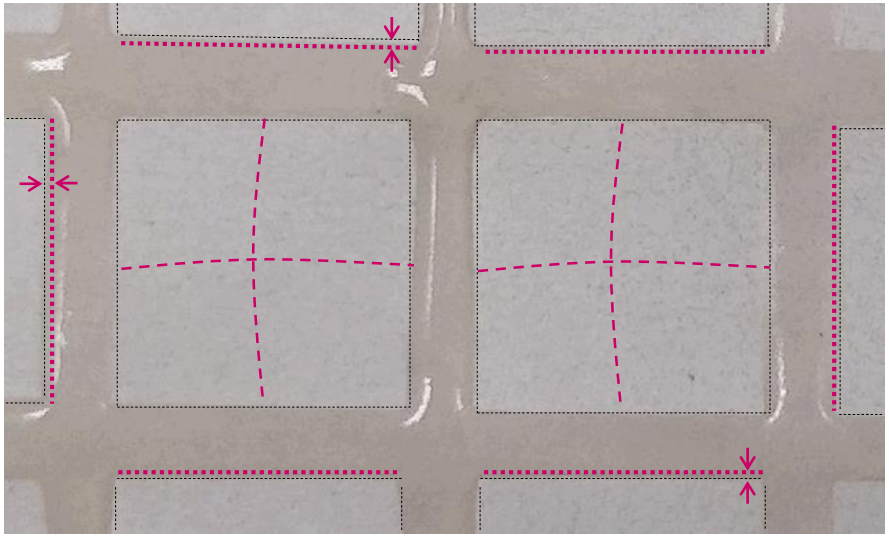
Namoco, 2010

Understanding

- **3D topography formation mechanism**
  - **Drying shrinkage of starch**
  - **Paper buckling between printed lines due to sheet shrinkage**



Grid printed with a specific experimetal set-up



Air drying, time-laps **x1800**

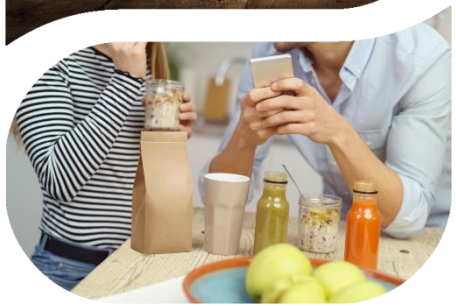
Potential applications

- **High reduction of paper basis weight**
  - Flexible packaging
    - Wraps, bags or sachets
  - Stiff packaging
    - Folding board boxes
    - Corrugated board
    - Cups
    - Clamshells
  - Tablecloth
  - Envelopes
  - Wallpaper
  - Edition
    - Book cover
    - Dividers



sherpack





Thank you for your attention

Any question?

Bio-based Industries Consortium

Horizon 2020
European Union Funding
for Research & Innovation

BBI JU