Trends and Technology Advancements in Paperboard Packaging

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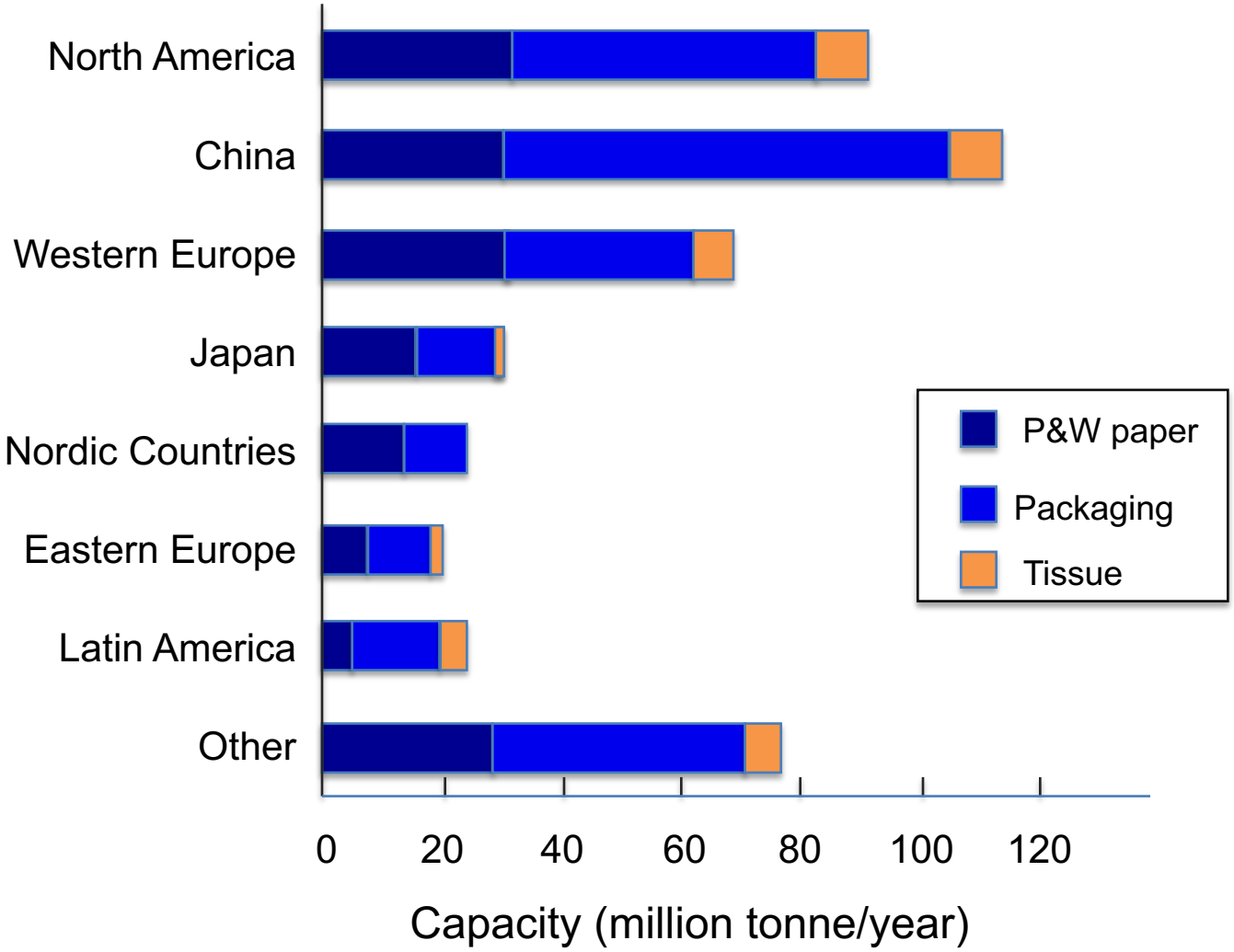
Outline

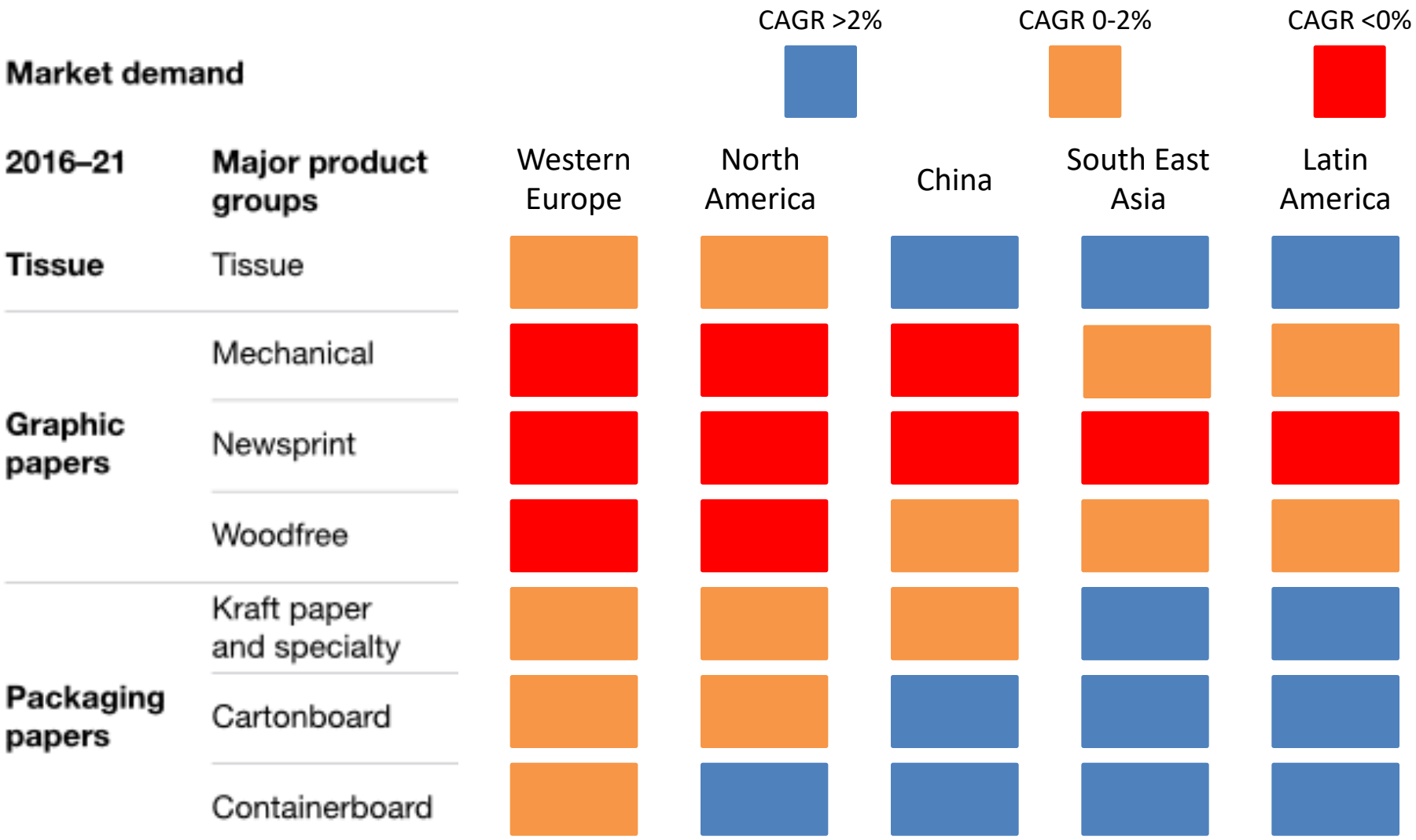
- Introduction
- Trends in packaging
- Technology advances
- Approaches to enhance paperboard performance
- Summary

Packaging Has the Largest Tonnage among Fibre-based Products



Source: Poyry， 2014

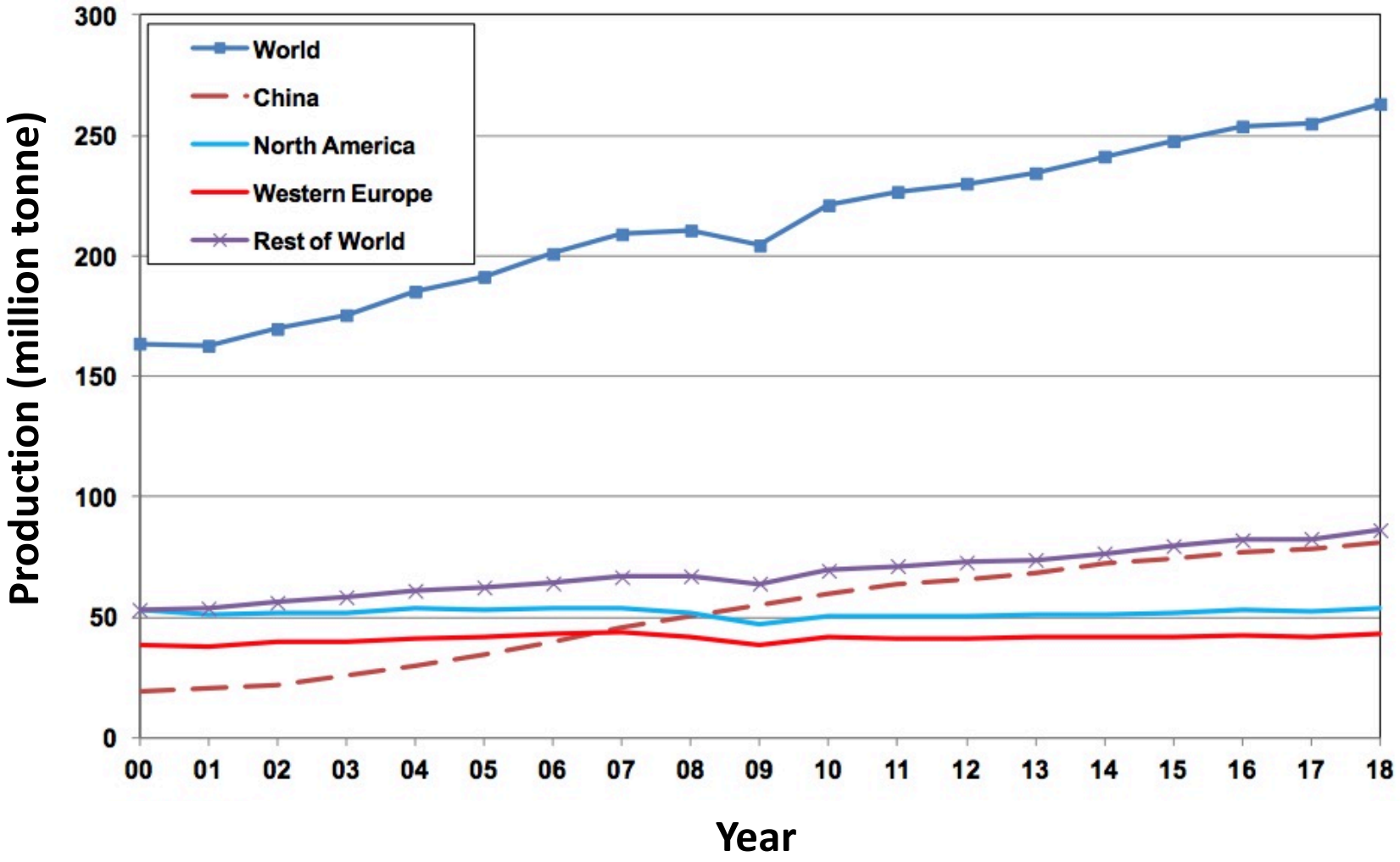
Overall Market Trend



Sources: McKinsey & Company

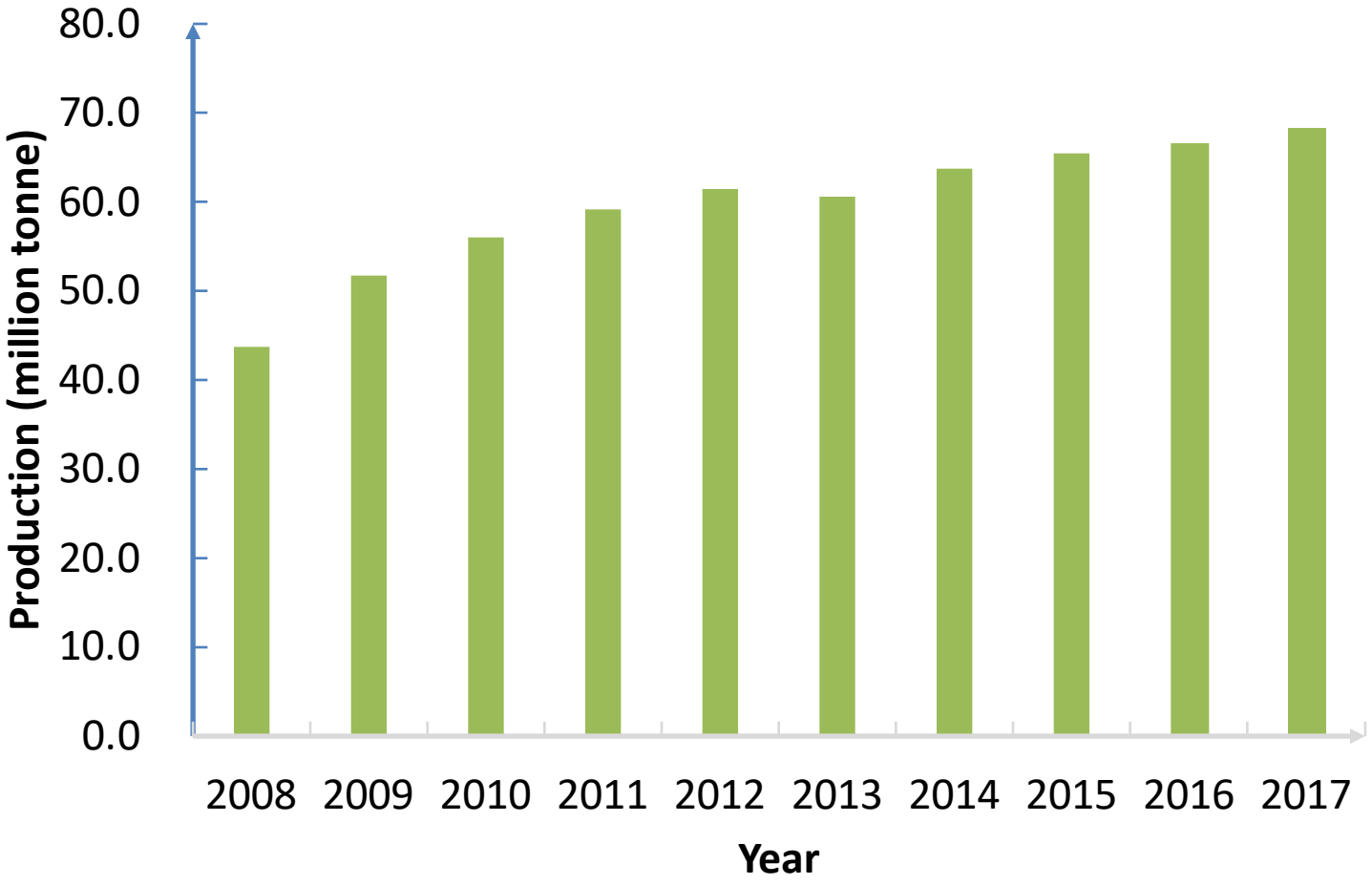
Berg & Lingqvist, McKinsey & Co, 2017

Packaging Production Continues to Grow



Source: RISI

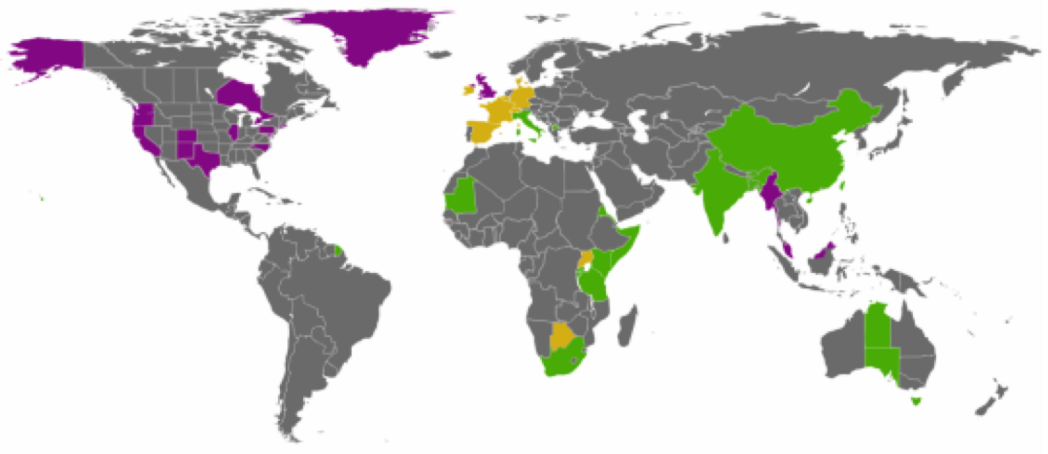
Packaging Production-China



Source: China Pulp and Paper Industry, 2018

Packaging Trends and Drivers

- Prevailing challenge: Sustainability
  - Opportunities for wood fibre based packaging
- Impact on packaging business
  - **Lightweighting**
  - Circular economy
- Main drivers
  - Major brand owners/retailers
  - Governmental regulations
- Enablers
  - **Performance & functionalities**
  - **Use of new biomaterials**



Plastic bags banned
A tax on some plastic bags
Partial tax or ban (municipal or regional levels)

https://priceonomics.com/where-are-plastic-bags-banned-around-the-world/

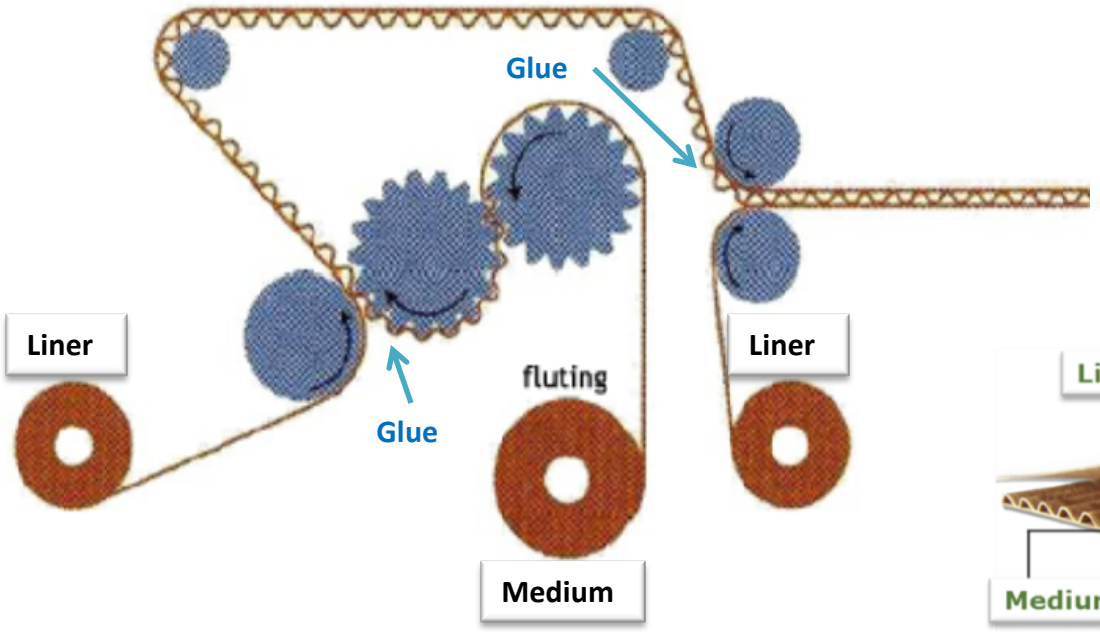
Advance in Paperboard Machine Technology - Towards Super-lightweighting

Start-up Year	1980	1990	2000	2010	2020
Technical Concept	W-type HB 2 Fourdriniers Conventional 3 nip press Traditional bond size press	Converflo Bel Baie (horizontal double wire) Extended nip Traditional sizer	Dilution cronntrol HB Gap formers Shoe press Film sizer	Hydraulic HB 2-ply High-speed gap former Double shoe press Film sizer	Hydraulic HB 2-ply High-speed gap former Double shoe press Film sizer New type of sizer?
Dimensions					
Trim **Design speed** **Capacity**	4,900 mm 450(700) m/min 75,000 t/y	7,460 mm 1,000 m/min 230,000 t/y	7,600 mm 1,500 m/min 350,000 t/y	10,100 mm 1,900m/min 650,000 t/y	10,100 mm 2,300 m/min 650,000 t/y
Basis Weight					
Lower end of BW (g/m^2)	120-140	110-120	90	75	60

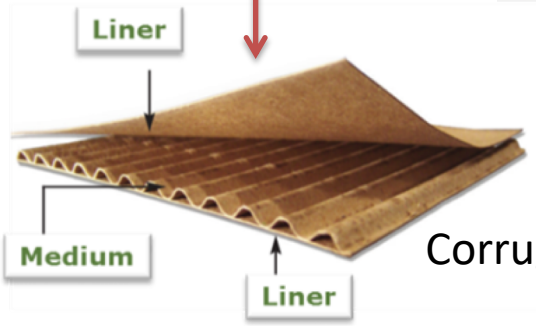
Ref: P. Resvanis et al, ProPapier, IMPS Conference 2012

Containerboard (box) Requirements

A corrugation process



Boxes

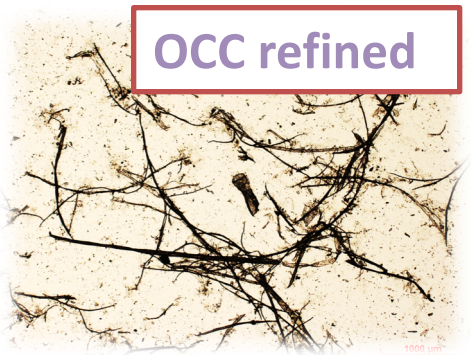


Corrugated board

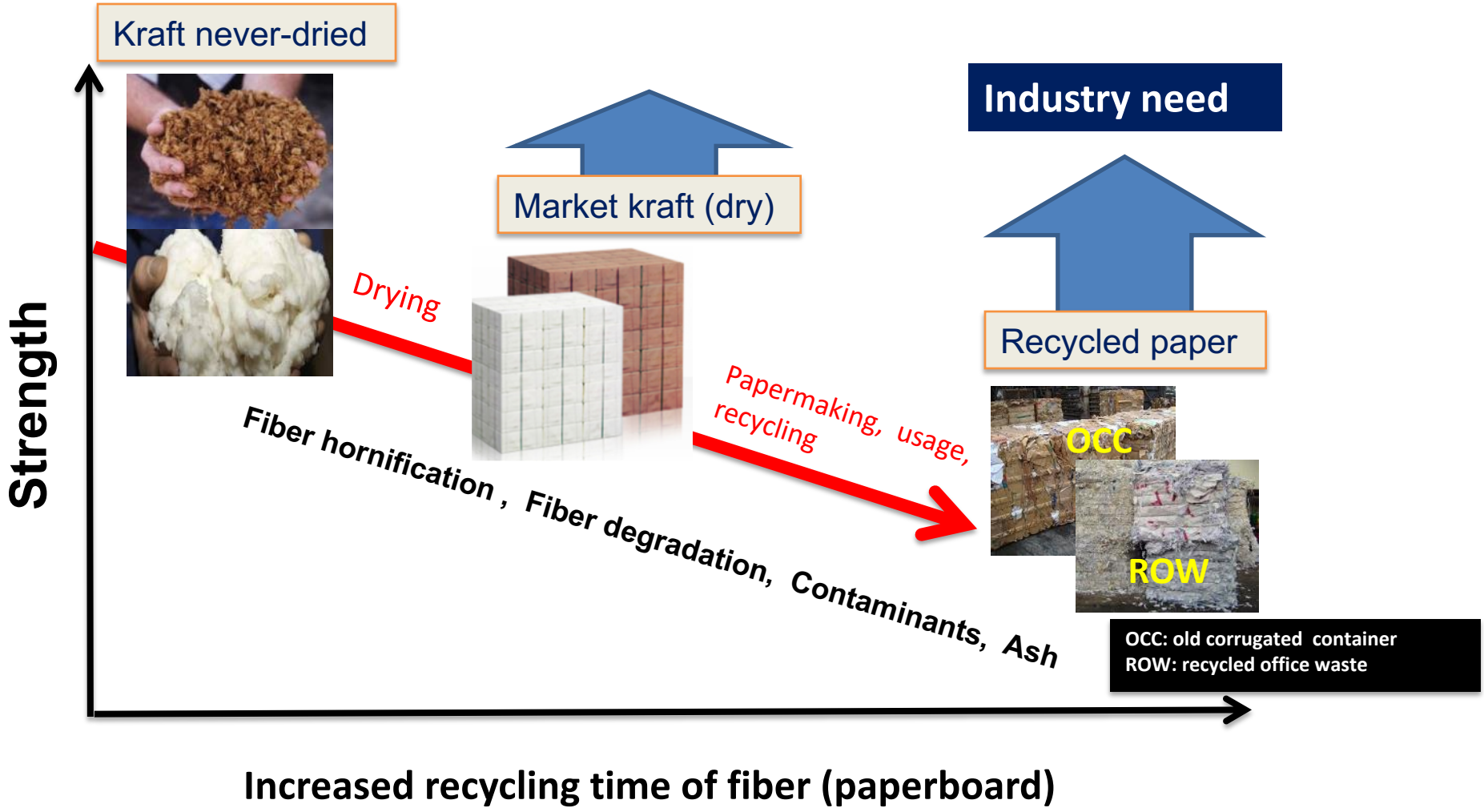
The resistance of a box starts with its materials: a strong liner, a conformable medium, and their humidity resistance. These are necessary for corrugation and box fabrication processes, and for the end use performance.

Raw materials

- Recycled fibers
  - 64% overall fiber raw materials
  - 20% import, 10% from US
- High cost
  - Limit the import waste goods from overseas
- Fiber properties
  - More short fractionation
  - More foreign materials



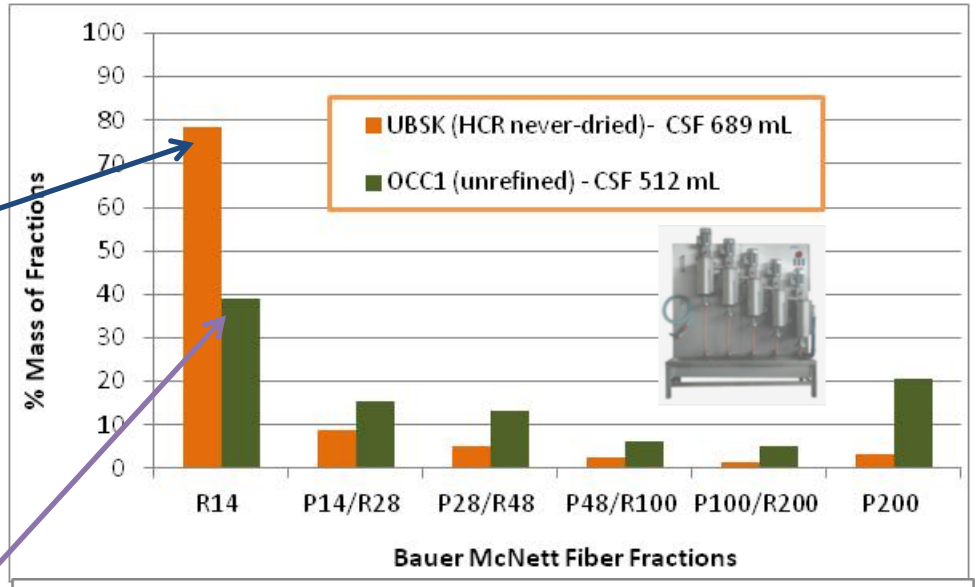
Impact of Recycling Times on Strength

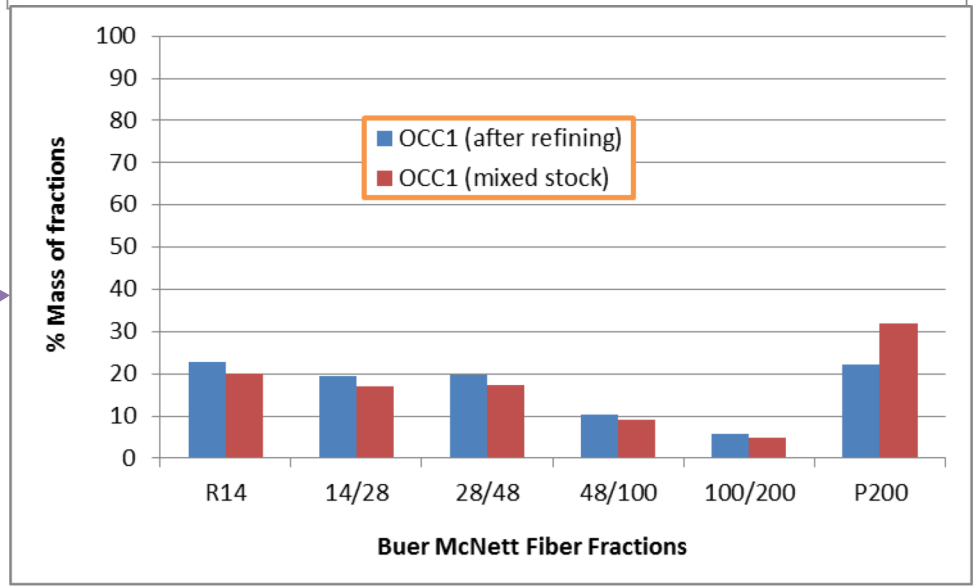


Recycling Times on Fiber Properties

UBSK

OCC
ROW

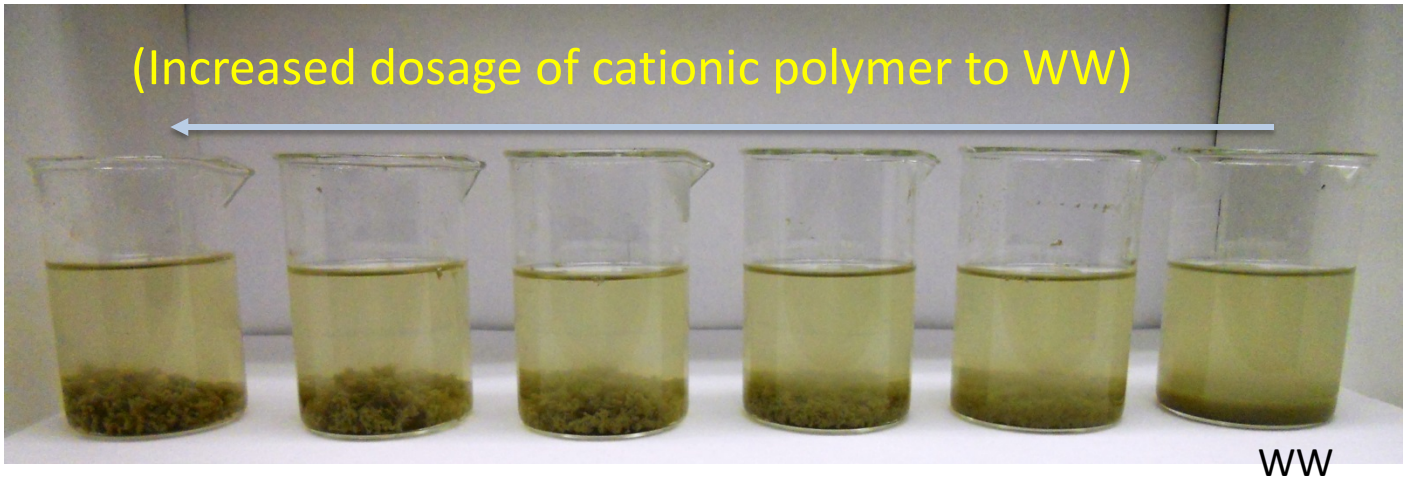




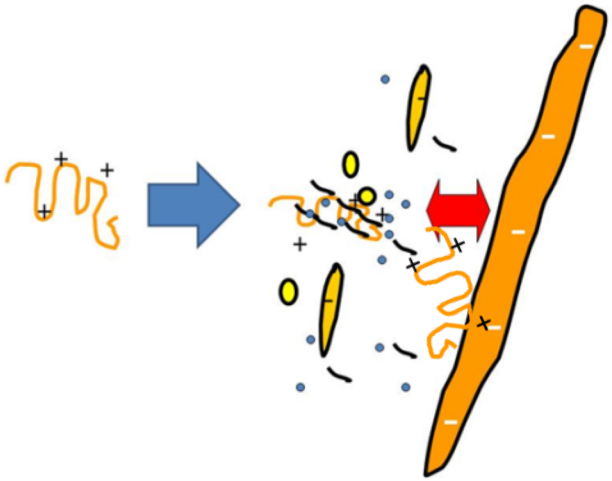
Addition of Cationic Starch Increases Strength

Sheet properties	No Starch Retention aid system	12 kg Starch / ton + Retention aid system	24 kg Starch / ton + Retention aid system
Grammage, g/m^2	149	148	147
Density, g/cm^3	0.580	0.596	0.601
Ash, %	5.14	5.29	5.18
Tensile, km	3.60	4.29	4.39
Scott bond, J/m^2	391	502	519
STFI-SCT, Nm/g	24.24	25.18	25.38

Cationic Starch Problem



WW
Control sample



White water of OCC furnish contains high level of fines, DCS and ash that can consume large amount of added cationic polymers

Liquid Packaging Board (LPB)

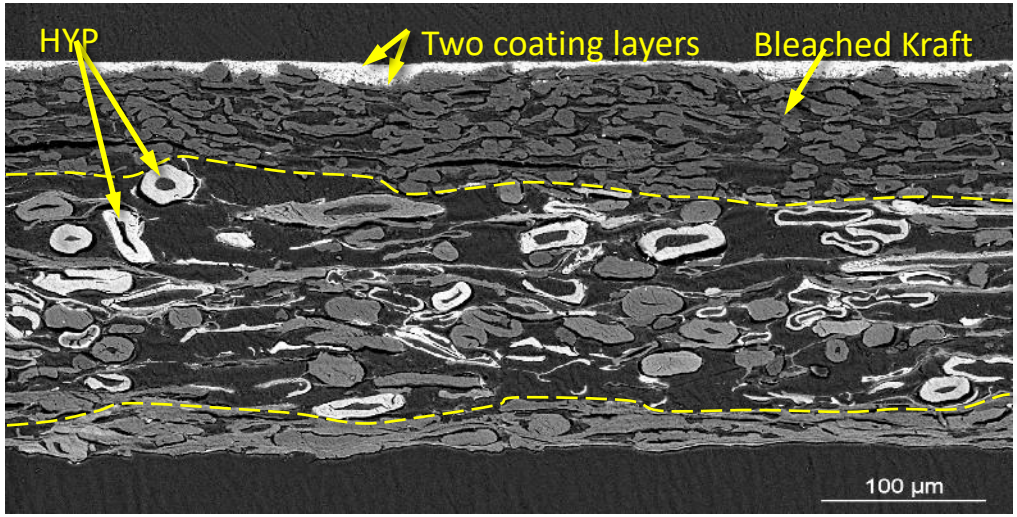
- A rapidly growing market, particularly in China
  - Demand in 2016: 700,000-800,000 ton (most of it is imported from North America and Europe)
  - 12-15% estimated growth rate for next 5 years
  - A few large LBP board machines have been built in China
- Main requirements for BCTMP in LPB applications
  - Bulk, bending stiffness and folding strength

Typical Composition of Chinese LPB

- Total grammage: 210 g/m²
- Grammage of each layer: 50/120/40 g/m² (top/middle/bottom)
- Composition of top and bottom layers: 50% SW/50% HW (kraft)
- Composition of middle layer: 65% kraft and 35% BCTMP
- Freeness of each layer: 425~500 CSF

Top ply
(Bleached Kraft)

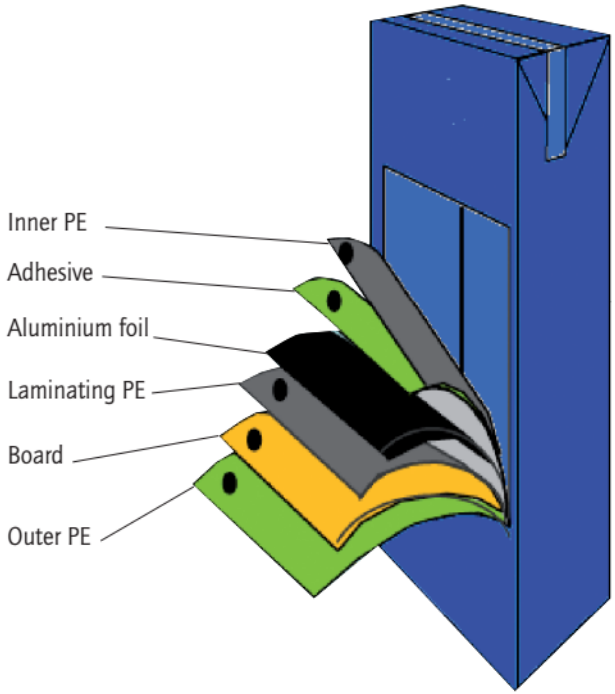
Middle ply
(mix of BCTMP and Kraft)

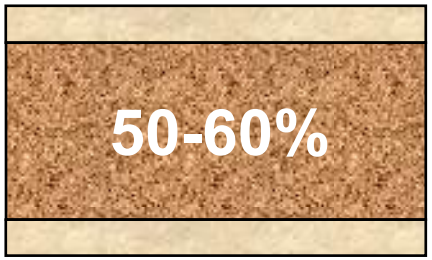


Zou et. al, IMPC 2014

Structure of LPB

- Basic weight : 180-280 g/m²
- Bulk : 1.3-1.6 cm³/g
- Paper as the substrate :75%-85%
- Edge penetration value:≤1.2kg/m²
- Cobb value:≤35g/m²





→ Top ply **Bleached Softwood/Hardwood**

Brightness

→ Middle ply **Unbleached Softwood/Hardwood+BCTMP**

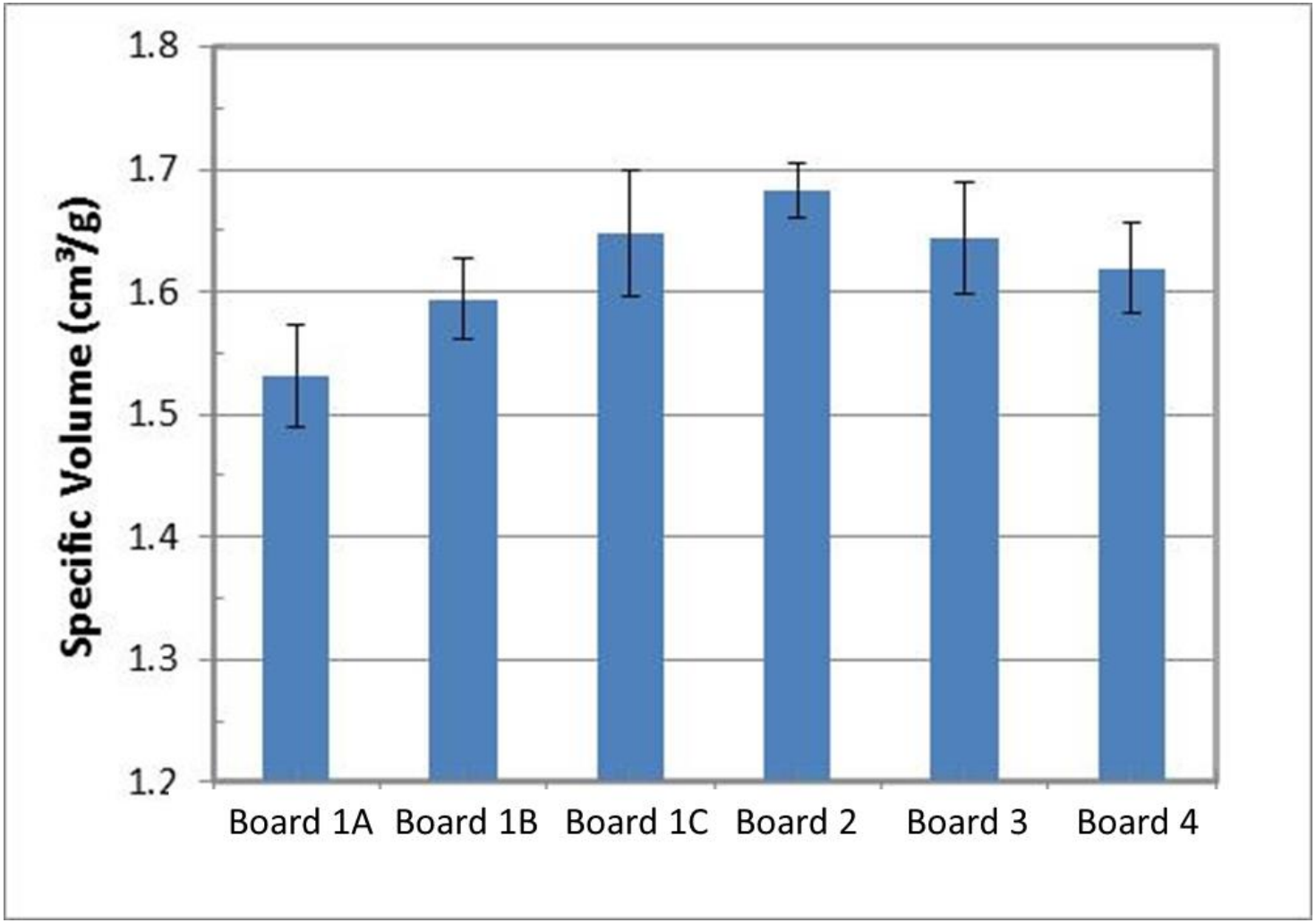
Bulk

→ Base ply **Bleached/Unbleached Softwood/Hardwood**

Strength

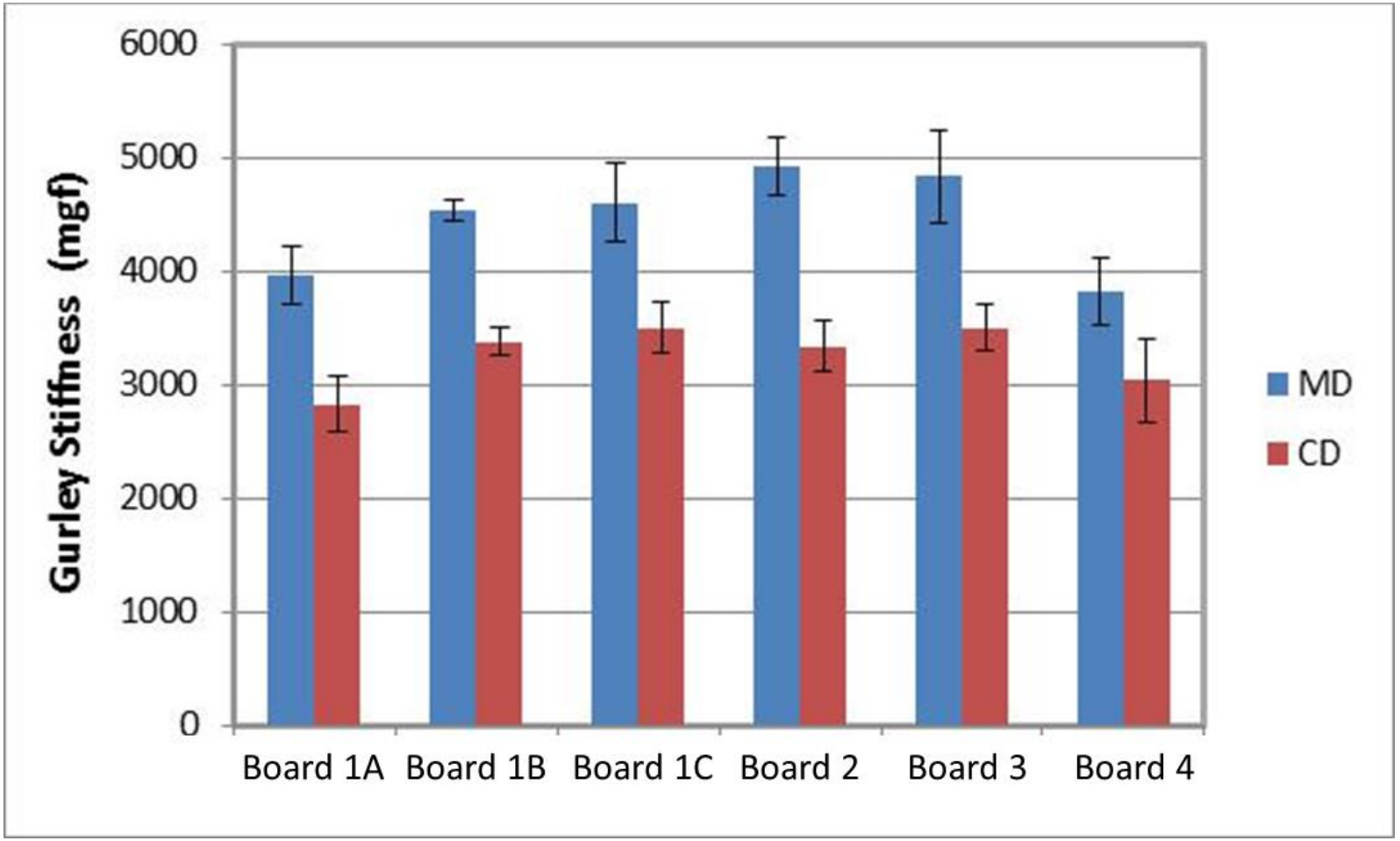
Source: SIG Combibloc, Tetra Pak and Pira International Ltd.

LPB Baseboard with Different BCTMP Type in Mid-ply - Bulk



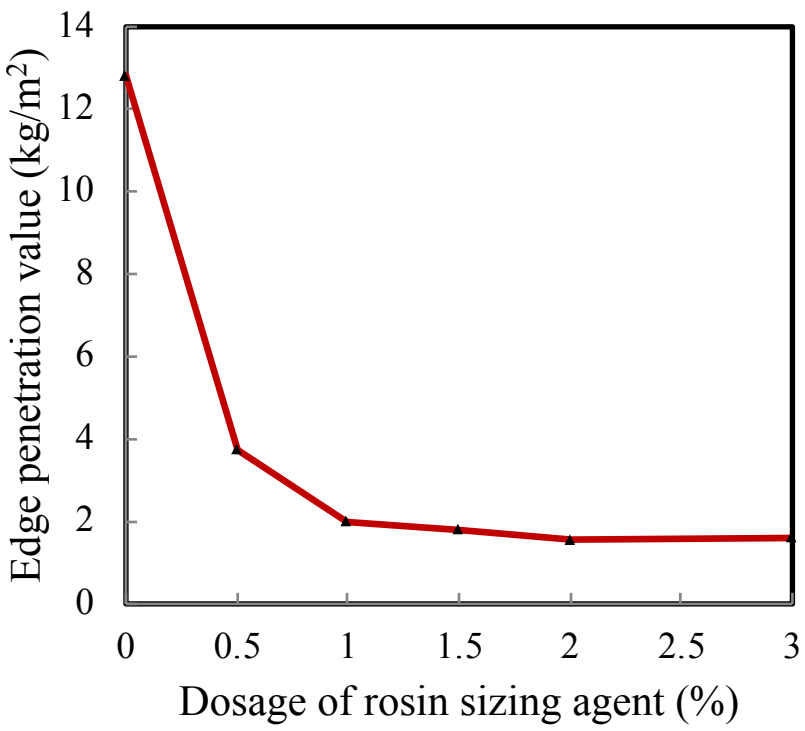
Zou et. al, IMPC 2014

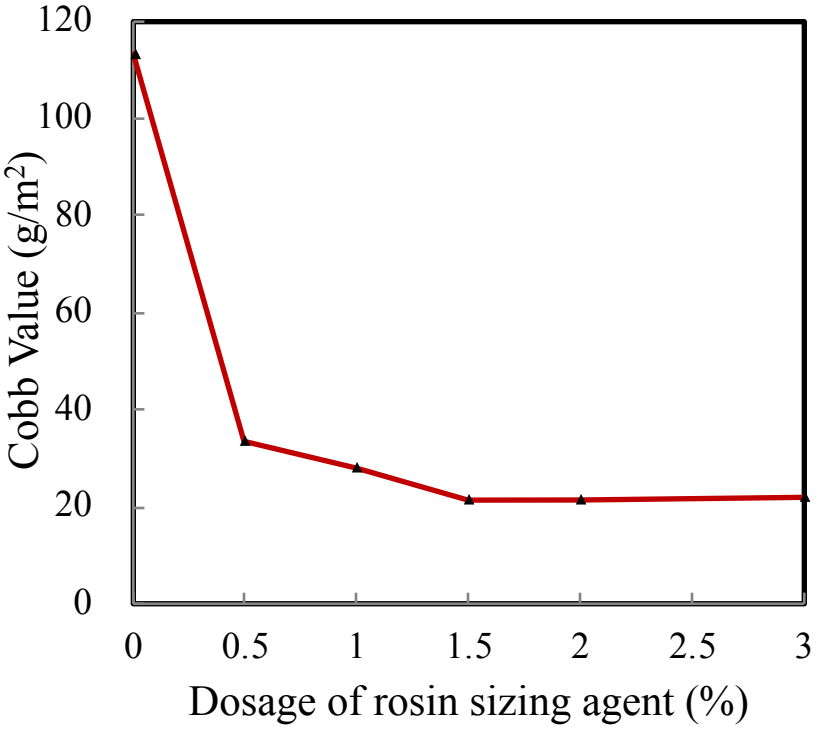
LPB Baseboard with Different BCTMP Type in Mid-ply - Bending Stiffness



Zou et. al, IMPC 2014

Effect of Rosin Sizing Agent





Edge penetration value and Cobb value decreased with the dosage of rosin sizing agent.

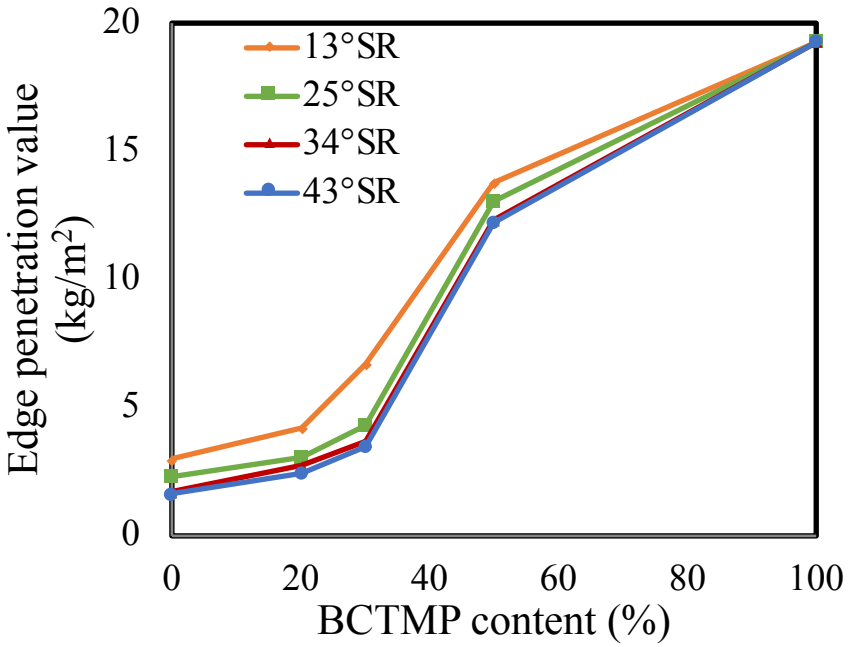
Pulp Types on Edge Penetration Value

The effect of pulp type on paper structure and edge penetration value

Pulps	Edge penetration Value (kg/m^2)	Paper structure		Flow resistance
		Average pore size (μm)	Porosity (%)	
UBKSP [a]	1.73	1.76	62.09	0.60
Poplar BCTMP [a]	19.25	5.07	80.04	0.08
Poplar BCTMP [b]	3.74	1.88	71.26	0.23
Pine BCTMP [b]	8.28	1.95	73.26	0.18
Maple BCTMP [b]	9.62	2.35	74.86	0.15

a 100% USBKP and 100% poplar BCTMP; b The ratio of UBKSP and BCTMP is 7:3.

BCTMP Contents on Edge Penetration Value and Paper Structure



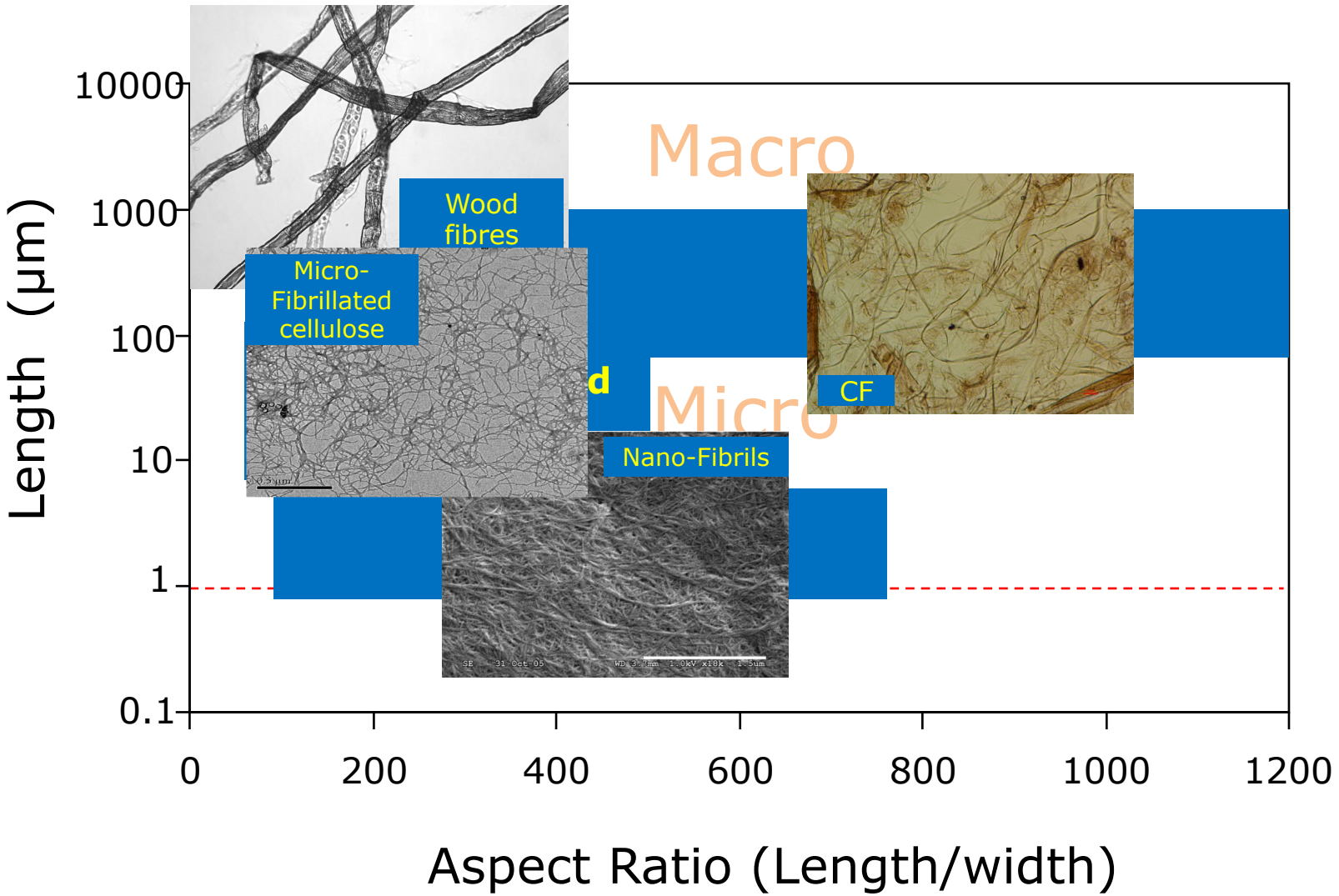
Effect of the dosage of BCTMP on the edge penetration value

The effect of dosage of BCTMP on paper structure

BCTMP (%)	Paper structure		Flow resistance
	Mean pore size (μm)	Porosity (%)	
0	1.76	62.09	0.60
20	1.81	68.58	0.31
30	1.88	71.26	0.23
50	2.84	74.11	0.16
100	5.07	80.04	0.08

- The more BCTMP,
  the larger pore size and porosity,
  the lower flow resistance,
  the worse edge penetration value.

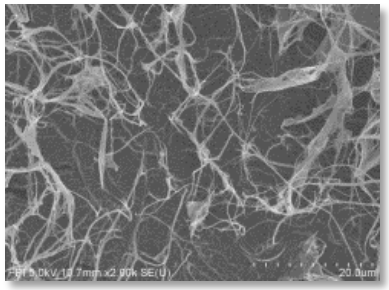
Cellulosic Biomaterials for Enhancing Strength



Hua, PaperCon 2016

Application in Reinforcing Linerboard

- A small amount of cellulose filament addition can improve strength
  - Inter-fibre bond strength
  - Compression strength



Nano fiber, %	Grammage, g/m^2	Bulk, g/cm^3	Tensile index, Nm/g
0	59.6	1.61	51.1
0.1	58.5	1.63	53.1
0.2	59.3	1.63	54.1
0.3	58.3	1.64	56.2

Top layer of paperboard

Overall Summary

- Demand for paperboard packaging is growing
  - Driven mainly by e-commerce and sustainability
- Performance is important
  - Depending on the end-use applications (e.g. containerboard vs liquid packaging board)
- Continuing trend in lightweighting
  - Raw materials
  - Paper machine technologies
  - Chemicals (starch, new polymers)
  - Use of biomaterials

Green Fiber-based Packaging

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