The FiberLean® MFC process

- Co-grinding pulp to MFC in the presence of minerals.
  - The mineral acts as a very fine grinding media
- Robust and reliable equipment of relevant industrial scale.
- On-site manufacturing, using a minor side stream of mill pulp.
- No chemistry involved.
- The FiberLean product is a MFC/mineral composite.

- A wide range of pulps can be used
- Also flexible with regard to the mineral
  - GCC
  - PCC
  - Kaolin
  - Talc
  - TiO₂
FiberLean® performance summary
Imerys has signed two separate commercial agreements for the full-scale supply of FiberLean® MFC, with two leading papermakers, one in Asia and one in the USA.

Imerys will have 8,000 dry metric tonnes per year capacity of MFC with the completion of these two plants,

A Food and Drug Administration (FDA) Food Contact Notification for Imerys FiberLean® MFC became effective in November 2015 for use as a food contact substance in paper and paperboard.

Imerys S.A. and Omya AG have entered into exclusive negotiations to form a 50:50 technology Joint Venture, FiberLean® Technologies, to promote the research and development of Micro Fibrillated Cellulose (MFC) concerning a variety of applications and industries.

The commercialization of MFC is to be independently and separately undertaken by Imerys and Omya commercial teams.
The FiberLean® contracts are for filler increase application in P&W

- MFC added to give initial wet web strength and bond strength to allow increased filler loading.
- Filler loading optimized for paper machine operational efficiency, quality and cost reduction.
- Some quality advantages traded to mitigate loss in bulk.
- Most significant remaining quality advantages are higher opacity and lower permeability, offering advantages in coating or printing.
Filler increase and MFC dose in FiberLean® CWF/UWF trials

**Full scale experience has proven:**

- 1% MFC makes it possible to increase filler by 5-6% (absolute).
- Our target of 2% MFC allowing 10% filler increase is realistic.

As an average we reached 9% filler increase from 1.77% MFC addition.
Our target is 10% filler increase from 2% MFC addition.
Comparison of MFC/NFC products in filler increase application

- Fine paper furnish – 30% Pine, 70% Eucalyptus, refined to 550 CSF
- Hand sheets made at 80 g/m² on British standard sheet former with whitewater recirculation to maximise overall retention
- Samples taken after steady state had been obtained in the whitewater
- High addition levels of micro/nano fibrillated cellulose (FC) chosen to emphasise effects and differences between products
  - 3.8% at 15% filler loading
  - 5.0% at 20% loading
  - 6.3% at 25% loading
Fibrillated Cellulose products compared cover a wide range

- FiberLean commercial product, mechanical processing only
- FiberLean+ development product, mechanical processing only
- FC 1: Pilot scale product of unknown processing
- FC 2: TEMPO-mediated oxidation followed by homogenisation
- FC 3: Enzyme hydrolysis followed by homogenisation
- FC 4: Commercially available MFC product without chemical treatment
Paper strength vs. filler content, showing different MFC/NFC’s have similar performance
FiberLean® MFC is available for full scale trials

Interior of FiberLean pilot plant in Trebal, UK showing Big Bags used to transport FiberLean in granulate form to customer trials.

FiberLean make down unit (MDU) "in action" preparing slurry for dosing to a paper machine.
FiberLean® for applications in specialty papers and packaging

- Taking advantage of the positive impact on strength, porosity and opacity.

- The presentation will focus on our experience from,
  - Increasing quality of specialty papers
  - Higher quality multi-layer board
  - Using MFC to take another step into the future
Full scale trial aimed at increasing bond strength
40-120 g/m² one/two side coated papers for printing, label and food wrap

- The critical level of bond strength required for a new paper application was achieved.
- With gains in opacity and smoothness.
Full scale trial aimed at improving surface without losing strength
40-120 g/m² one/two side coated papers for printing, label and food wrap

- Addition of 3% MFC made 12% extra filler possible with maintained strength.
- At this level there was improved surface smoothness and significantly increased gloss.
Selecting correct filler loading and sheet weight with FiberLean®

Pilot paper machine data

- **Paper with no MFC**
  - 63 g/m²
  - 8% filler
  - 84% opacity
  - 1.5 kN/m tensile

- **Paper with 2% MFC**
  - 53 g/m²
  - 17% filler
  - 84% opacity
  - 1.5 kN/m tensile

- **Paper with 4% MFC**
  - 48 g/m²
  - 21% filler
  - 84% opacity
  - 1.5 kN/m tensile

**Graph**

- **84% Opacity no mfc**
- **84% Opacity 2% mfc**
- **84% Opacity 3% mfc**
- **84% Opacity 4% mfc**
- **1.5 kN/m tensile strength no mfc**
- **1.5 kN/m tensile strength 2% mfc**
- **1.5 kN/m tensile strength 3% mfc**
- **1.5 kN/m tensile strength 4% mfc**
First full scale use of FiberLean® in board outer layers

Whitelined Chipboard

- Maintained visual and optical coverage
- Maintained Scott Bond
- Improved retention in top layer (53 to 61%)
Radical full scale use of FiberLean®, in board outer layers

Folding Boxboard

<table>
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<th>Bulk</th>
<th>Stiffness</th>
<th>Roughness</th>
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</table>

Relative impact on key quality parameters:

- Top ply basis weight reduced by 4-5 g/m² or ≈15%
- Back ply basis weight maintained constant

Reference: No MFC No filler
FiberLean: 3.6% MFC 14.4% filler
FiberLean: 3.6% MFC 14.6% filler
FiberLean: 4.5% MFC 18% filler

SPECIALY PAPERS EU 2016
MANCHESTER, UK
Out of the box thinking for white boxes

- What if extreme levels of mineral and MFC were used to provide cost-efficient coverage of a dark kraft or recycled base?
- What if this top layer could be applied as a coating instead of as a separate web?
- What if the coating could be applied already on the wire to use existing dewatering equipment?
- Could this open up new possibilities for,
  - Upgrade of Kraftliner?
  - Upgrade of Testliner?
  - Added value conversions from P&W?
  - Other novel ideas?
Surface application of MFC and mineral

- This picture shows 0.3 g/m² of MFC on the surface of a paper board.
- It is applied as a FiberLean composite made with kaolin.
- The challenge is to increase the amount of MFC in light of its high viscosity and low solids.
- We believe the path forward is to apply MFC and minerals (FiberLean) as a “wet-end coating”
Wet-end coating offers exceptional coverage of unbleached base

All pictures show 40 g/m² of top ply with FiberLean applied as a wet-end coating.
Light weight coverage of a dark, spotty or rough base

Weight of "white top layer" and brightness when covering a 25 ISO brightness unbleached kraft base.

Compared with the 40 g/m² of 100% Eucalyptus giving a brightness of 67%, it only takes 15 g/m² of FiberLean to reach the same level, 63% less.

Wet-in-wet application of FiberLean composite with 20% MFC and 80% GCC on 25 ISO Brightness unbleached kraft base.
Conclusions and summary

- The use of MFC in paper making is now established.
- Different types of MFC/NFC show similar performance for filler increase in paper.
- There are opportunities to tailor the use of MFC to make specific quality improvements in specialty papers and packaging grades.
- The exceptional ability of MFC and mineral to give opacity with retained strength offers new and exciting possibilities.
- A summary of FiberLean performance shown:

<table>
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<th>MFC dose</th>
<th>Filler increase (absolute)</th>
<th>Basis Weight reduction</th>
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Thank you for your attention!