Silicone Technology for plastomer skin layer used in PE films

DOW CORNING™ AMB-12235 Masterbatch

Patrick Prêle, R&D andTechnical Support engineer, Masterbatch Technology

UL Prospector Webinar – June 13, 2019

DUPONT™

Today's agenda

- Welcome to a new DuPont
- Multibase – transforming innovation
- Silicone masterbatch technology for PE blown film challenges
- Experimental set-ups
- Technical results
- Conclusions

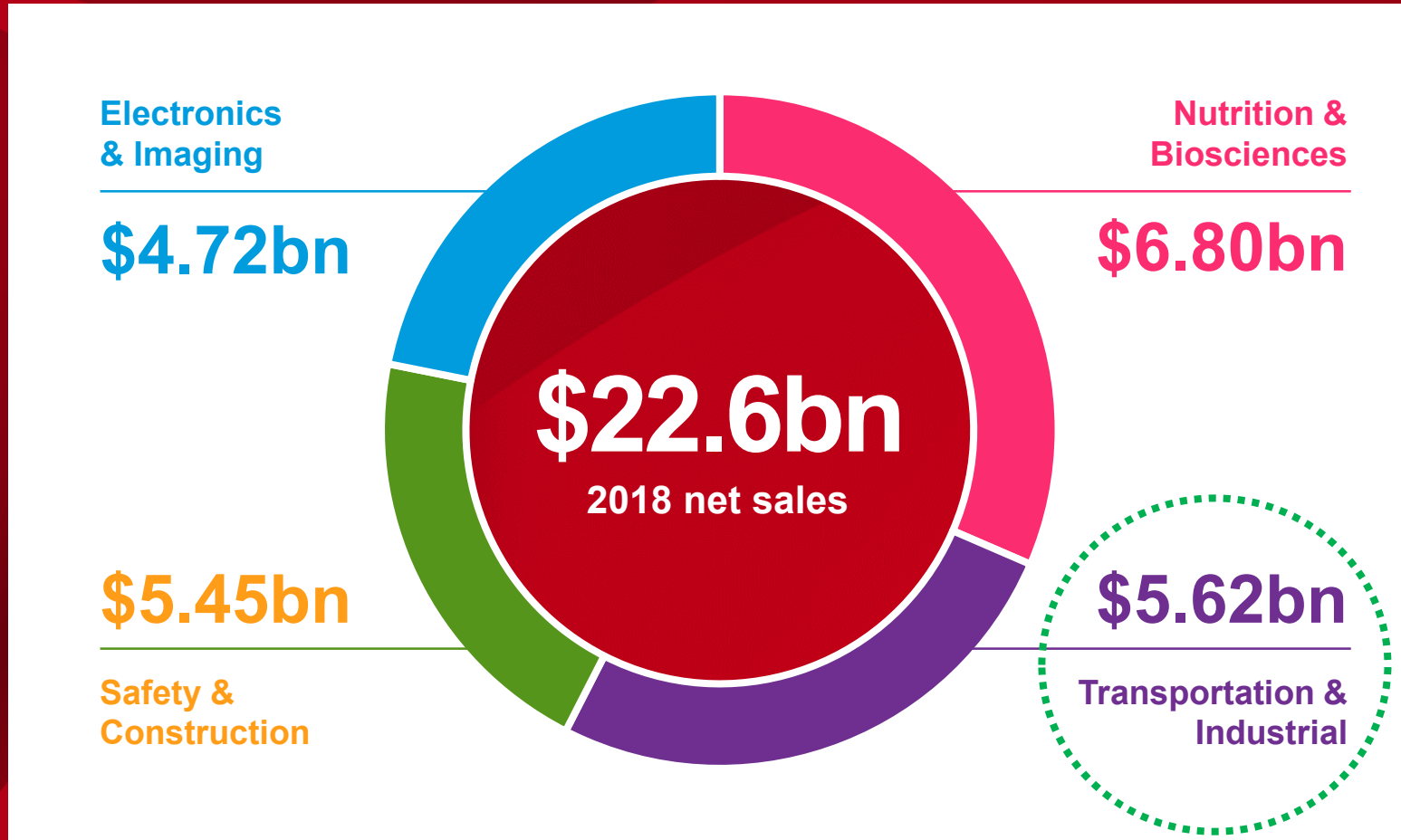
Driving innovation for a diverse set of industries

32,000+
Colleagues

200+
Manufacturing Sites

70+
Countries

10+
Global R&D Centers



DUPONT

DuPont Transportation & Industrial
Our solution space

Automotive & Advanced Mobility

Healthcare

Electrical/Electronics

Consumer

Industrial

Global capability. Local solutions.

Innovation Centers

- Brazil
- China
- India
- Russia
- Switzerland
- Japan
- Taiwan
- Turkey
- United States:
  - Silicon Valley, CA
  - Troy, MI

Major R&D Centers

- Brazil
- China
- France
- Denmark
- Korea
- Germany
- Netherlands
- Switzerland
- Japan
- Taiwan
- India
- United States:
  - Palo Alto, CA
  - Wilmington, DE
  - Marlborough, MA
  - Midland, MI

DUPONT

Multibase – transforming innovation

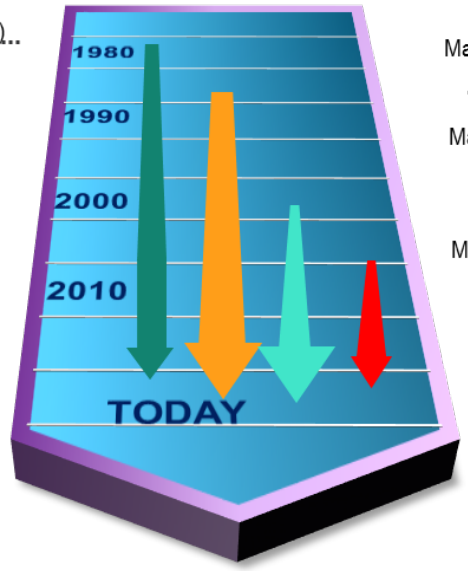
1980
50/50 joint venture
Paturle (steel) & Omya (fillers)

2002
Acquisition by Dow Corning & introduction of siloxanes

2016
Integration in Dow

2018 DowDuPont merger

June 1, 2019
New DuPont



1988
Manufacturing expansion
Copley USA

1996
Manufacturing expansion
Daman, India

2010
Manufacturing expansion
Zhangjiagang, China

A silicone-based technology solution to PE blown film challenges

DOW CORNING™ AMB-12235 Masterbatch

Industry challenges – PE Blown Films

Ensure long-lasting low coefficient of friction (COF)

- Seamsless throughput
- High Productivity
- Consistent quality during post-process operation such as FFS

Our solution to address the challenge

- A stable long-term COF will ease logistics and storage, and during post production process (e.g. FFS)
- The low content needed allows a reduced impact on haze

Silicone masterbatch technology – features & benefits

DOW CORNING™ AMB-12235 Masterbatch main features

- Does not migrate, does not transfer
- Efficient at low dosage, introduced in one skin layer only
- Can be used through conventional dosing equipment

Combining antiblock and slip agent allows

- Synergetic effects due to right combination and amounts of each active ingredients
- Ease supply and handling

Easy to process

- Free-flowing pellets
- Can be used in conventional dosing equipments and with usual PE blown film processing parameters
- Typical recommended level of use: 4-6wt%

Experimental Set-ups

Blown Film Fabrication Parameters

COF Measurements

Mechanical Properties

Transfer Test Description

Film Structures for blown film extrusion

Films with organic slip additive – organic reference

A	15µm	Plastomer (d=0.904 - MFI 1g/10 min) *+1% PPA* *Formulated with antiblock and slip agent*
B, C, D	15µm	LDPE - d=0.921 - MFI 1.9g/10min
E	20µm	LLDPE/LDPE 60/40 (MFI 2/1.9g/10min) + 1% PPA + 1% masterbatch silica as antibloc

Layer A: Skin layer in which slip properties are desired

Layer B, C, D: Core layer

Layer E: Opposite skin layer, potentially Corona-treated to be metallized or printed

PPA: Polymer processing aid: additive used to avoid shark skin on the film and ease the process

Film Structures for blown film extrusion

Films with silicone additive – DOW CORNING™ AMB-12235 Masterbatch

A	15µm	Plastomer - d=0.902 - MFI 1.1g/10 min - *No PPA, No antiblock, No slip agent* *+2, 4 and 6wt% DOW CORNING™ AMB-12235*
B, C, D	15µm	LDPE - d=0.921 - MFI 1.9g/10min
E	20µm	LLDPE/LDPE 60/40 (MFI 2/1.9g/10min) + 1% PPA + 1% masterbatch silica as antibloc

Layer A: Skin layer in which slip properties are desired

Layer B, C, D: Core layer

Layer E: Opposite skin layer, potentially Corona-treated to be metallized or printed

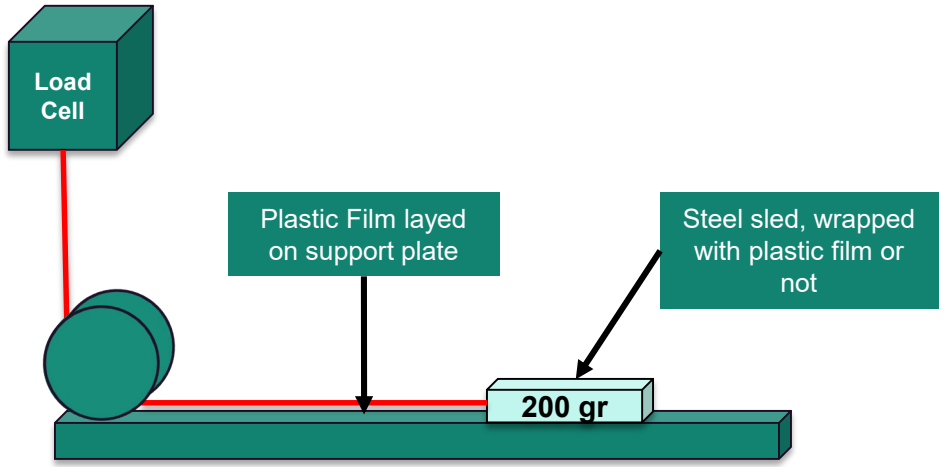
It is to be noted that DOW CORNING™ AMB-12235 **played the role of PPA** during blown film extrusion (thus, traditional PPAs could be removed of the formulation).

Tests Parameters

Coefficient of friction

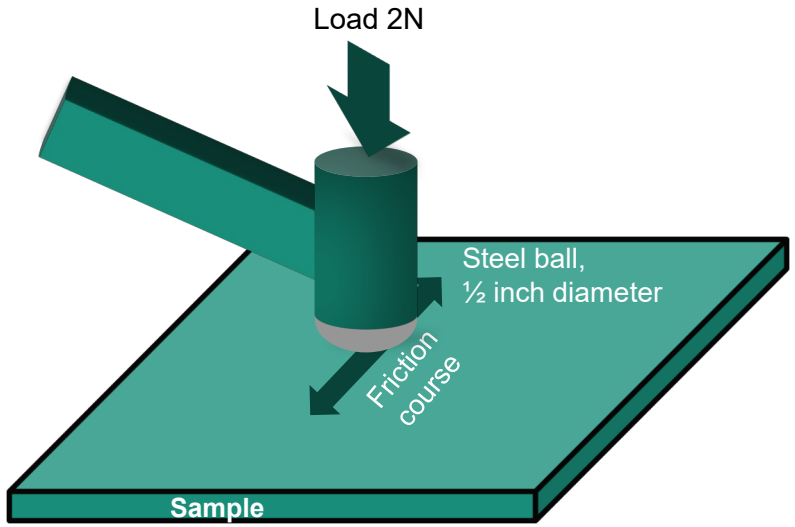
Zwick coefficient of friction, following ASTM D1894

- 254 mm x 127 mm 200g Sled
- Running speed: 150 mm.min^{-1}
- Running length: 60 mm
- *Film on film CoF measurements were made siliconized layer against siliconized layer.*



Film on Metal coefficient of friction

- Load: 2N
- Speed: 10 mm.s-1
- Total length of the test: 5m
- Number of cycle: 250
- Internal test method

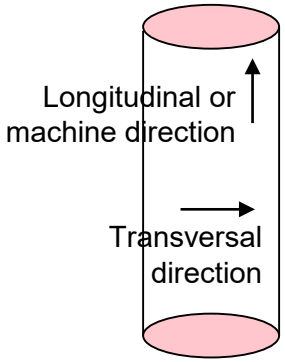


Tests Parameters

Mechanical Properties

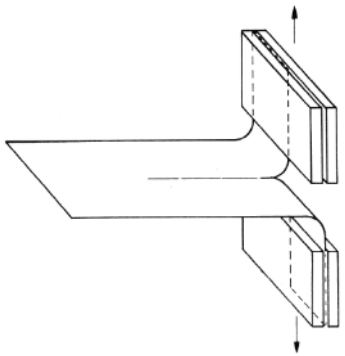
Tensile: Zwick equipment, following EN 13655:2002

- Running speed: 500 $mm.min^{-1}$
- Samples: 10mm width strips
- Gap between grips: 50mm



Tear test: Zwick equipment, following ISO 6383-1:2015

- Speed: 200mm/min



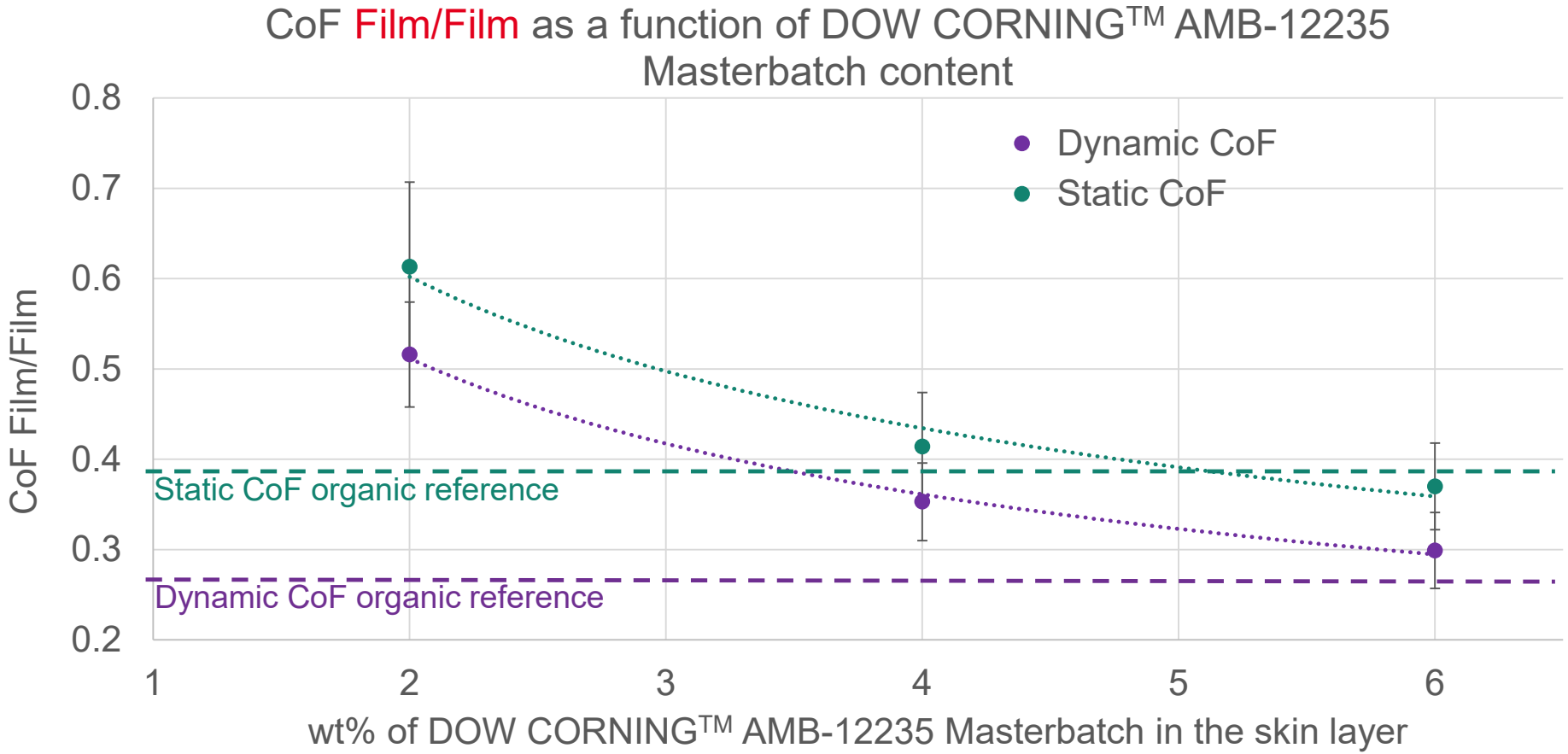
Technical results

COF Comparison

Mechanical Properties

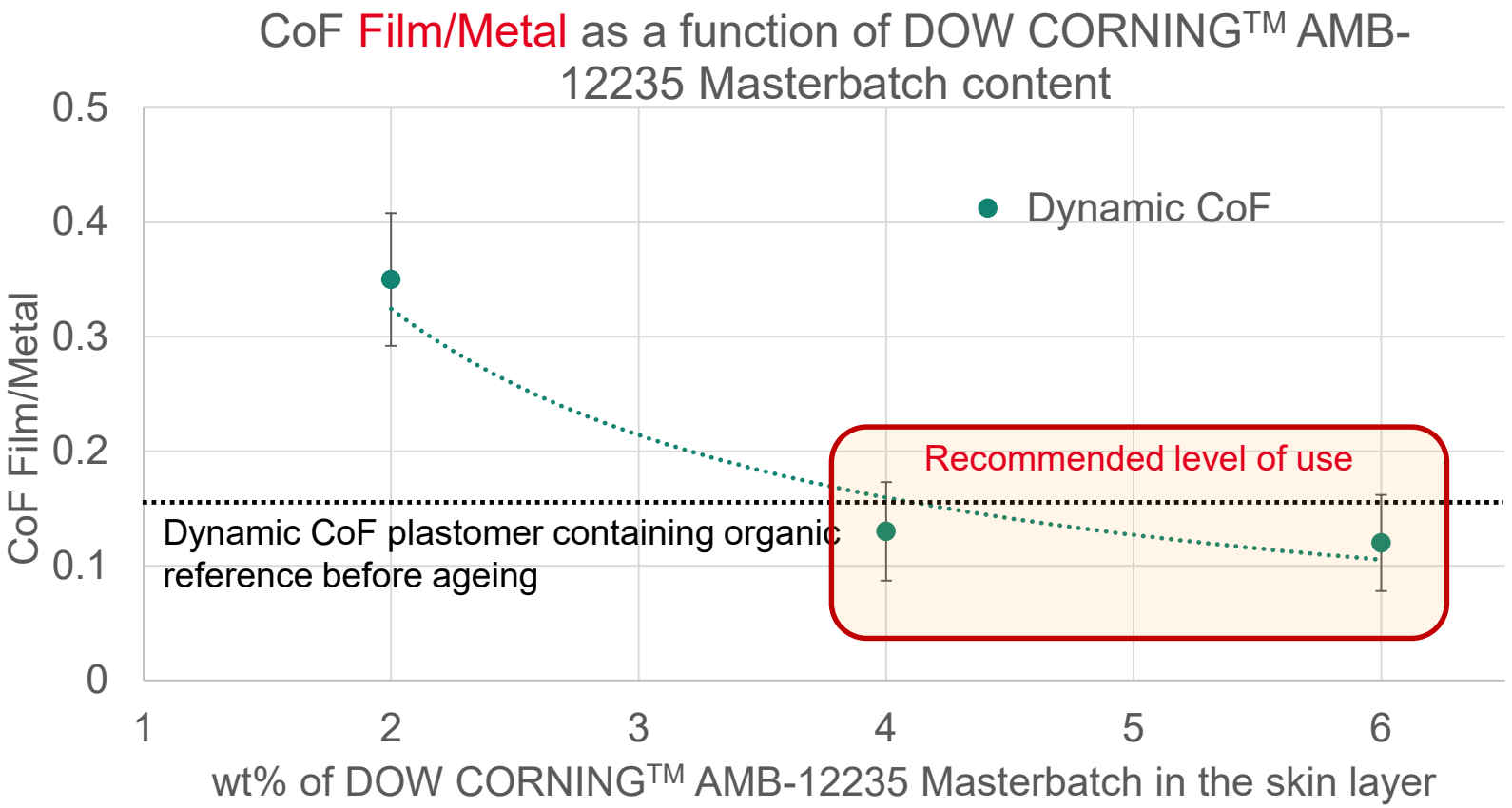
Transfer Analysis

Dynamic and Static COF Film/Film



An optimum is achieved at 4 to 6 wt% of DOW CORNING™ AMB-12235 Masterbatch with a CoF Film/Film around 0.35

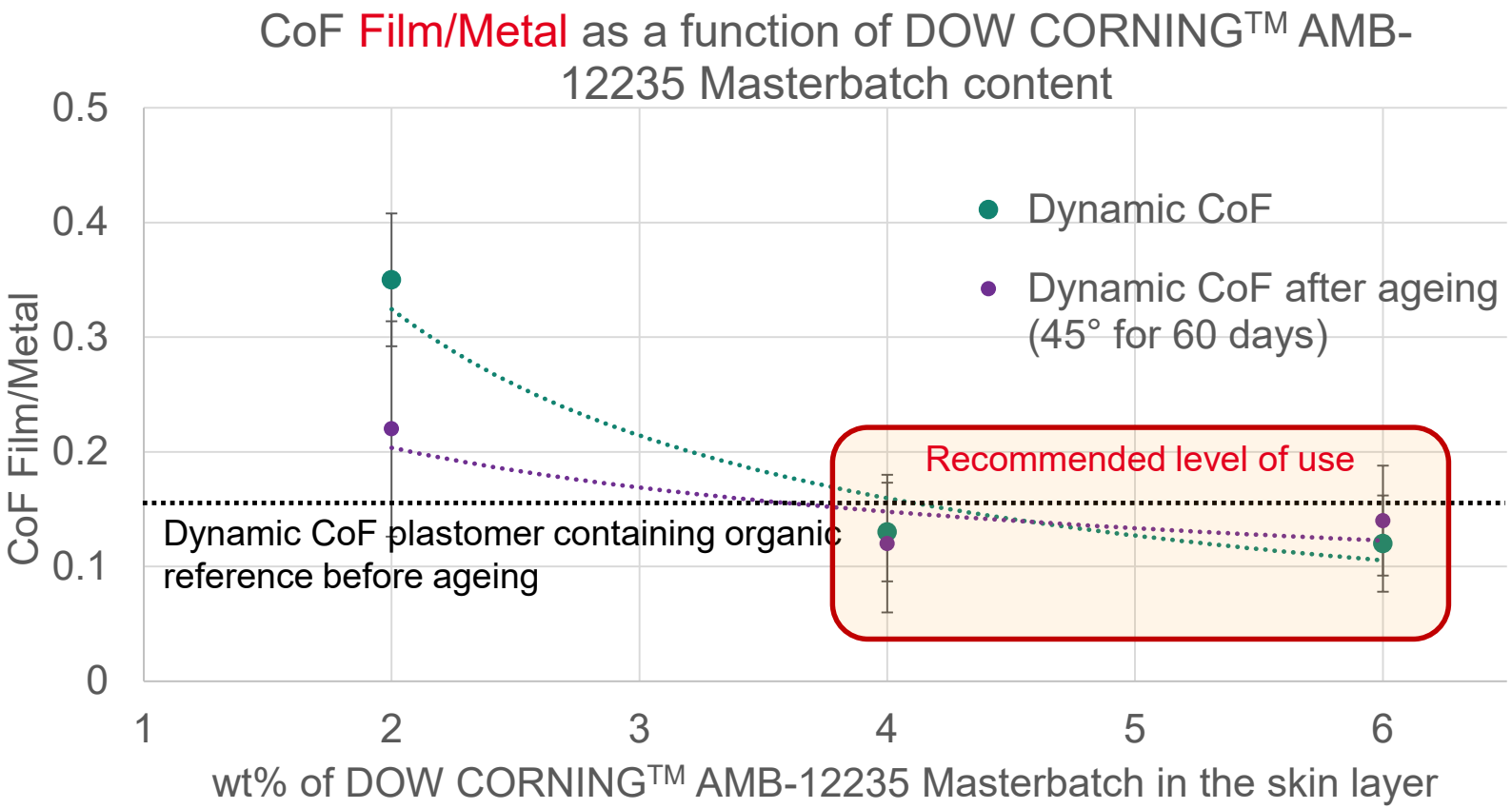
Dynamic COF Steel/Film *(ball on film)*



*NB: The Film/film COF is higher than reference **BUT** Film/Metal COF is lower than reference*

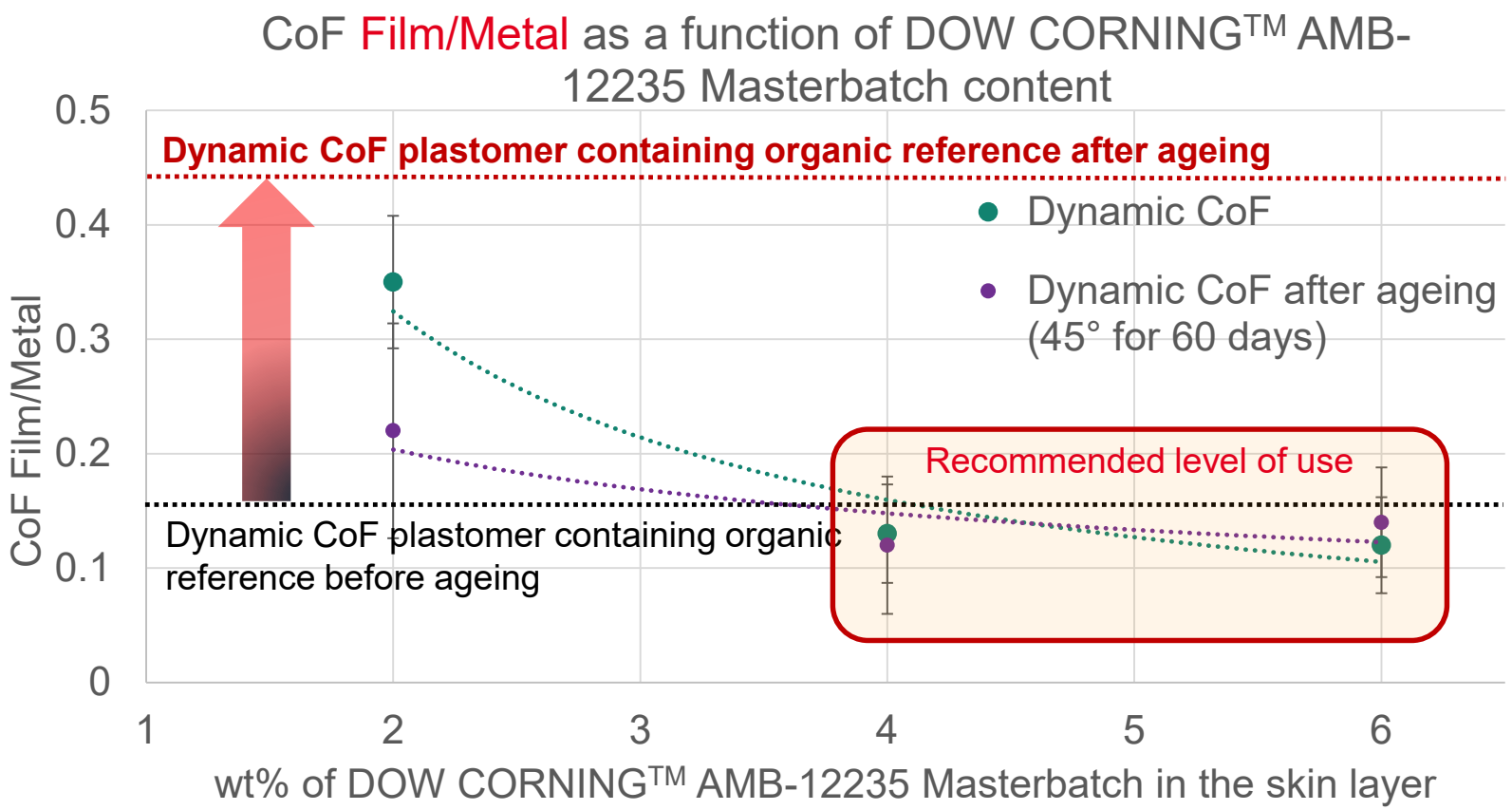
The film using DOW CORNING™ AMB-12235 is showing lower CoF than reference since 4wt% introduction

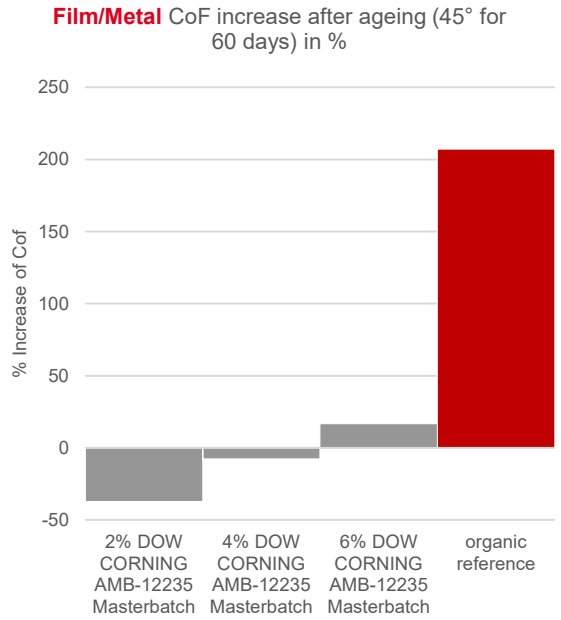
Dynamic COF Steel/Film after ageing



The CoF Film over Metal remains stable after ageing at 45°C for 2 months, while with the organic reference, it increases of 200%

Dynamic COF Steel/Film after ageing

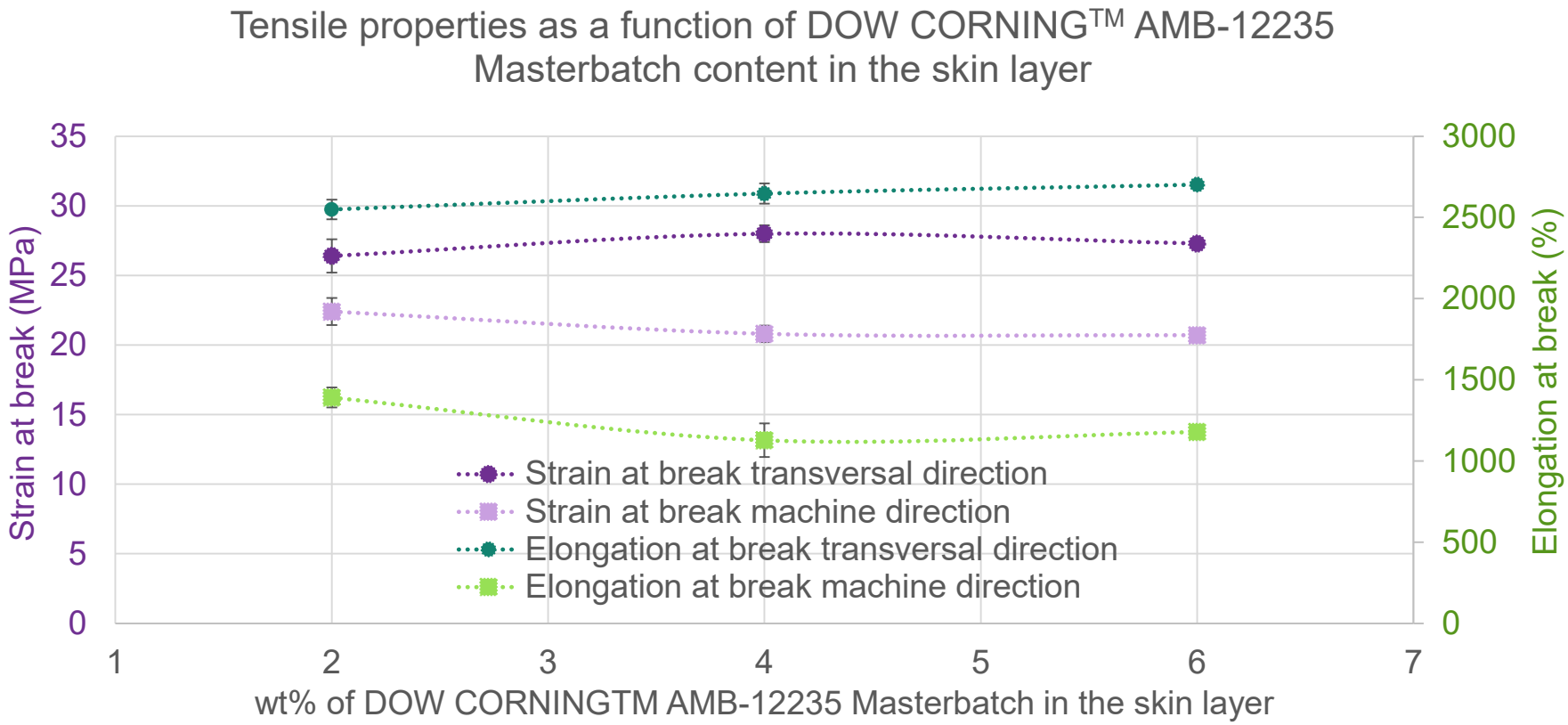




The CoF Film over Metal remains stable after ageing at 45°C for 2 months, while with the organic reference, it increases of 200%

Mechanical Properties

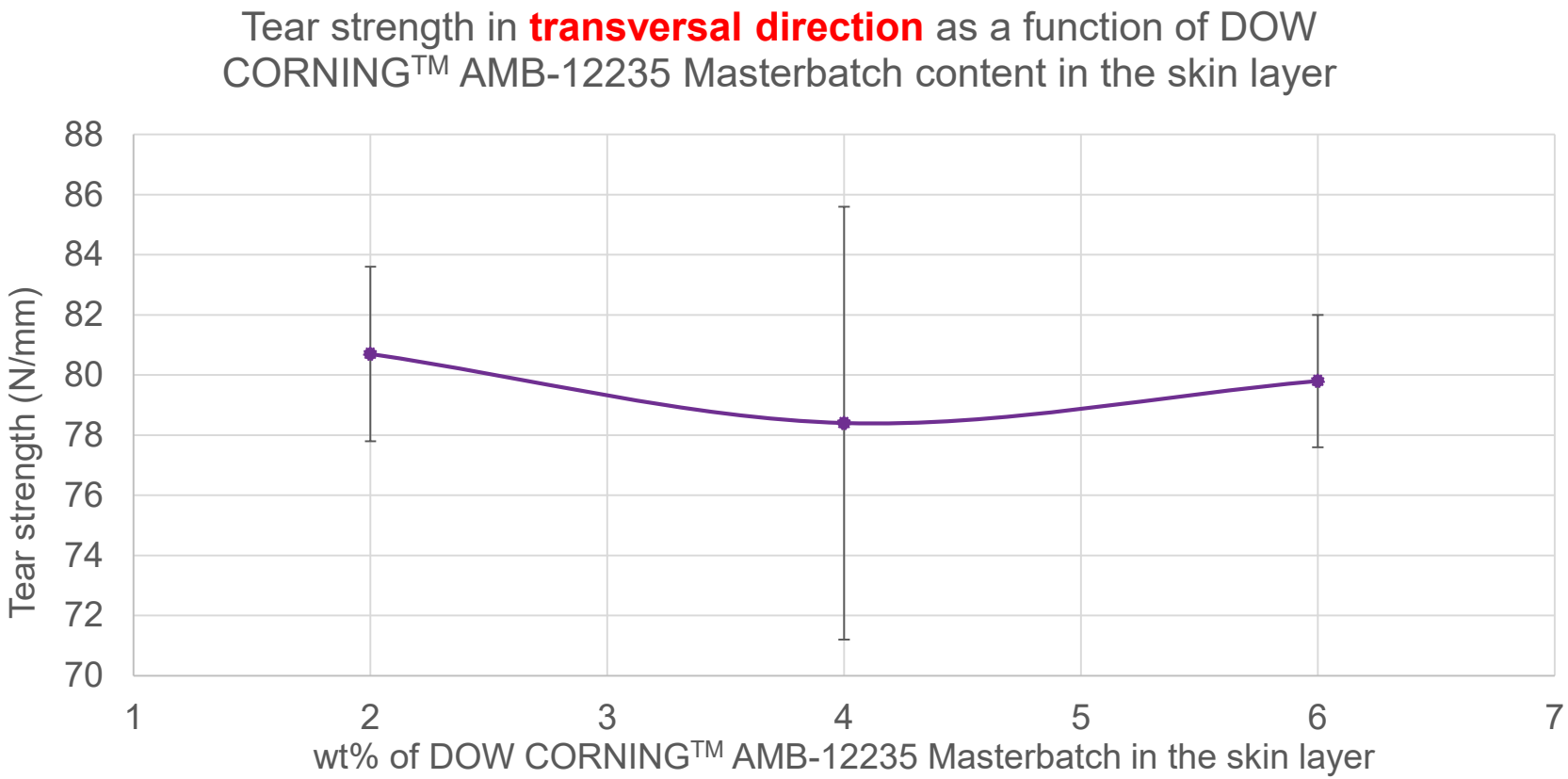
Tensile tests



The addition of DOW CORNING™ AMB-12235 Masterbatch does not affect tensile properties of the film

Mechanical Properties

Tear Strength Test



NB: Impossible to run the tests in the longitudinal or machine direction

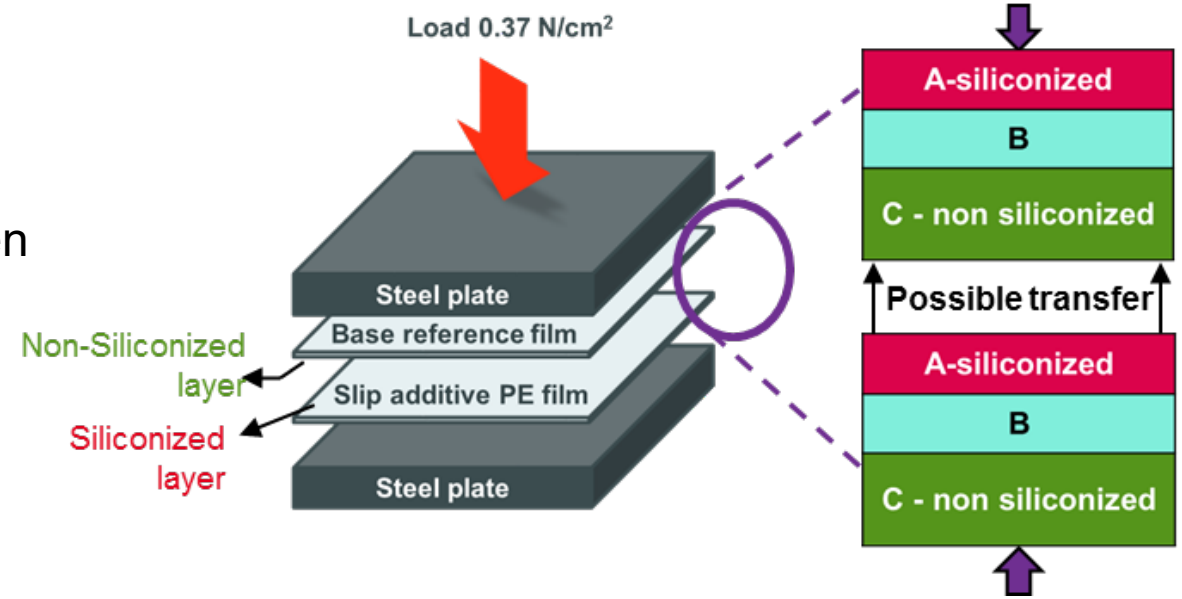
The addition of DOW CORNING™ AMB-12235 Masterbatch does not affect tear strength of the film

Tests Parameters

Transfer study

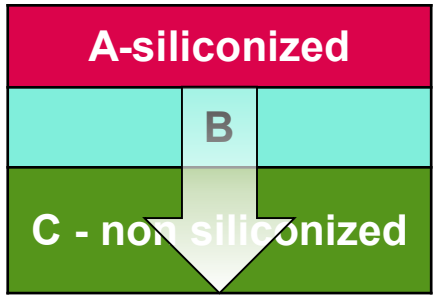
Contact migration test (after 2 months at 23°C under weight)

- Simulation of winding pressure by pressing films between metallic plates.
- Base reference PE film (containing no slip additive) and SiMB treated PE film are laid together with a 0.37N/cm² pressure. (weight 15 KG/ 20*20 cm)
- After exposure, IR ATR spectroscopy is conducted to track Si migration



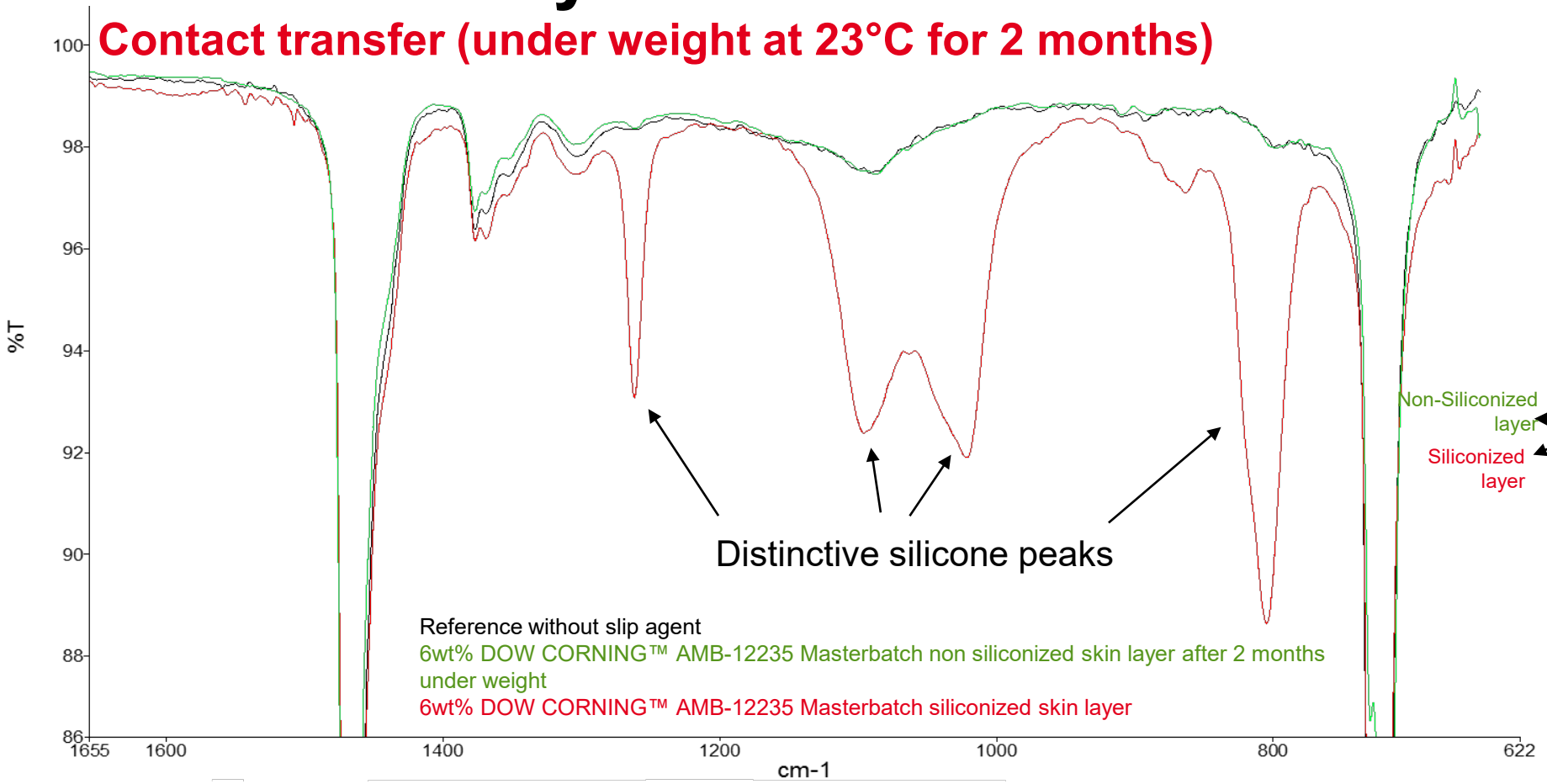
Intra-layer migration test (after 1 month at 60°C)

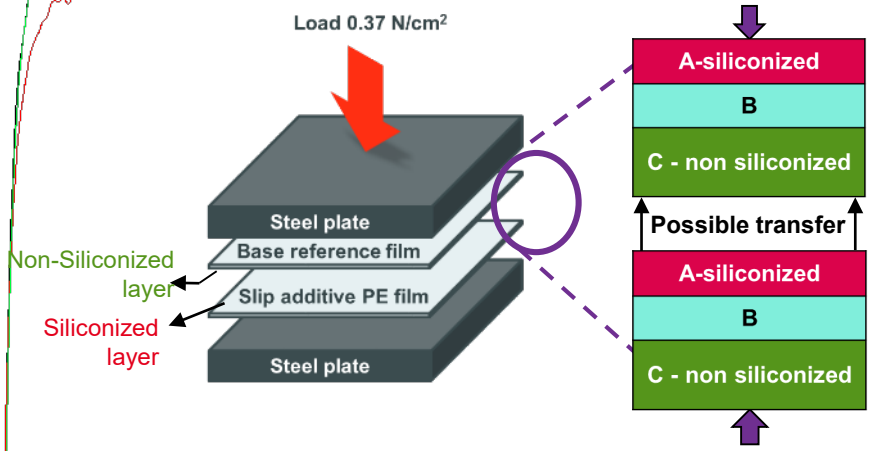
- The samples are stored for 1 month in an oven at 60°C to accelerate ageing and degradation
- Layer C (non-siliconized skin layer) is IR tested to see the presence of silicone or amide, coming from the opposite skin layer and migrating through all layers.



Transfer Analysis

Contact transfer (under weight at 23°C for 2 months)

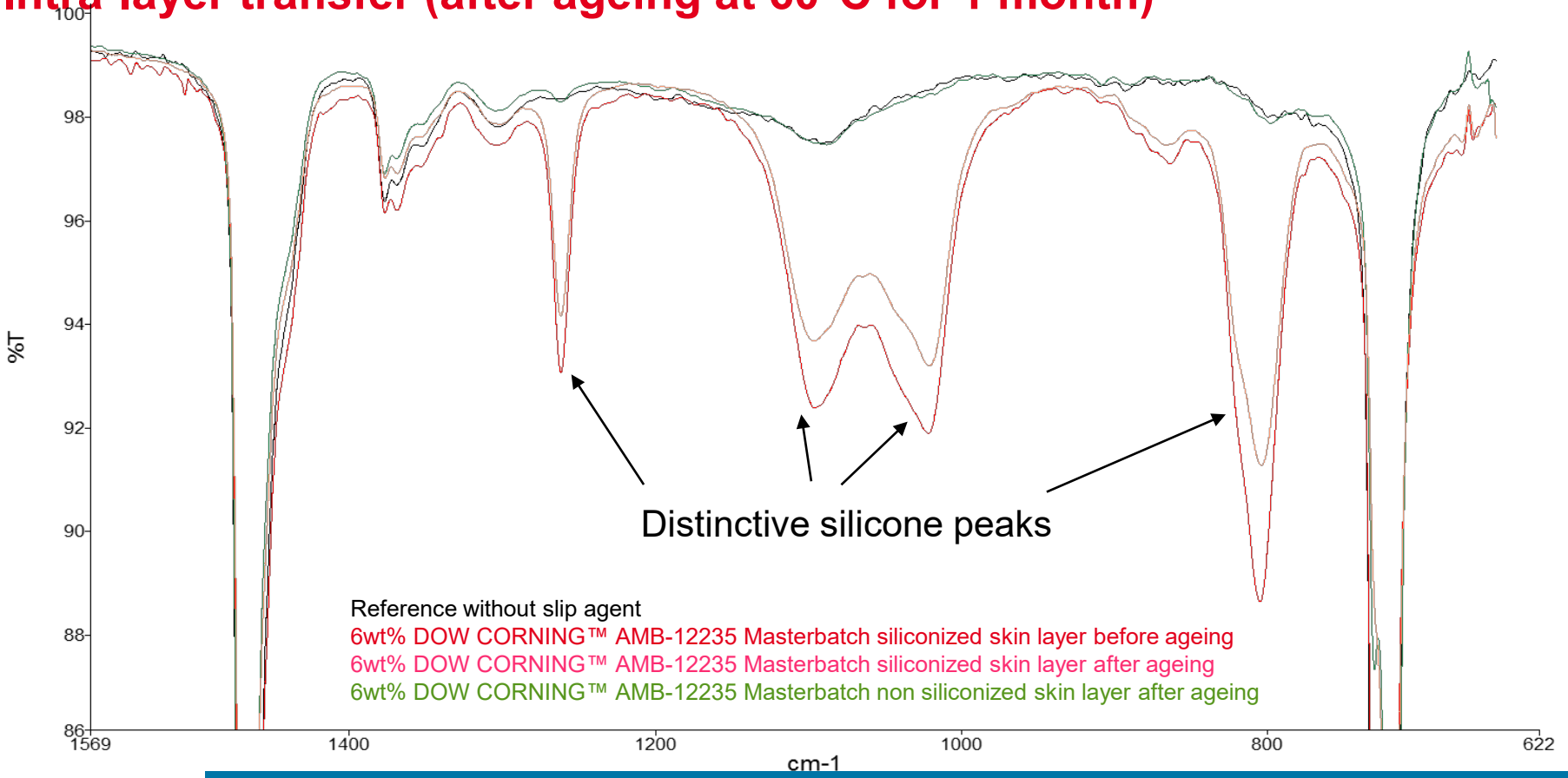


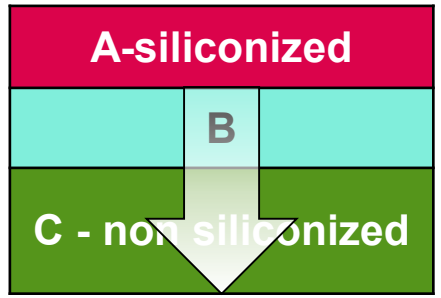


The silicone does not transfer by contact and under weight to the opposite non siliconized layer; this layer remaining printable and/or metallizable event at high loadings

Transfer Analysis

Intra-layer transfer (after ageing at 60°C for 1 month)





The silicone does not migrate through layers, even after ageing at 60°C for 1 month and even at high loadings.

Conclusions: Silicone Technology for plastomer skin layer used in PE films

Process

- PPA can be removed from formulation

Friction

- Film/Film COF: An optimum level is achieved at 4 to 6 wt% of DOW CORNING™ AMB-12235 Masterbatch around 0.35
- Film/Metal COF: The silicone additive shows lower COF than organic solutions
- *NB:* with silicone additive high COF film/film does not mean high COF film/metal.

We recommend customer measure film/metal COF when this is the desired outcome of using slip agent

Mechanical properties

- The silicone additive does not impact any mechanical property

Transfer

- The silicone does not transfer against a non siliconized layer by contact
- The silicone does not migrate through layer with time and temperature
- **Does not affect printing and/or metalization**

Cost

- The silicone additive is designed to be used at **low dosage** (4-6 wt%) and to be introduced in the desired skin layer **only**.

Our slip additives for films

	Resin	Typical film thickness	Product	Usage recommendation
PE blown films	PE – Density 0.9-0.902	13µm	AMB-12235 (*)	4-6%
	LDPE/LLDPE Density> 0.91	15 µm	MB25-235	2-4%
BOPP films	Terpolymer	1-2 µm	HMB-6301	2-3%

(*) contains anti-bloc

DOW CORNING™ AMB-12235, DOW CORNING™ MB25-235, DOW CORNING™ HMB-6301 are:

- food-compliant globally

- Free flowing pellets which can be used with conventional thermoplastic equipment/conditions

DUPONT

A question?

Technology

Patrick Prêle

R&D engineer & Technical support- MB technology

Multibase SA

DuPont

T: +33 47667 1246

patrick.prele@dow.com

Sales & Business

Barbara Meunier

Application Development Specialist

Multibase SA

DuPont

T: +33 47667 1228

barbara.meunier@dow.com