

PFAS FREE - משפרי עיבוד חדשים

חנה שוורץ

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PFAS

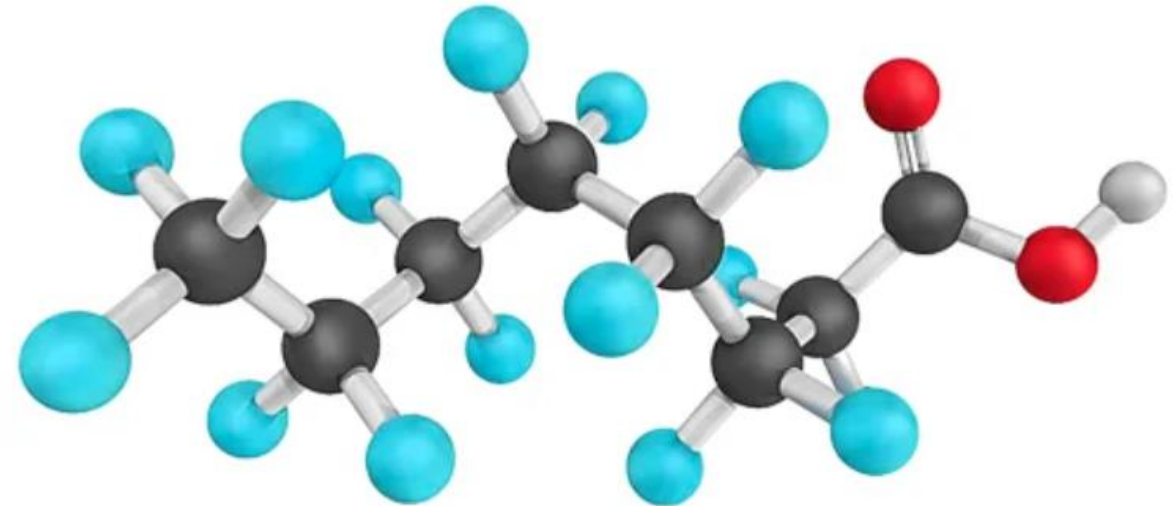
Per- and Poly Fluoro Alkyl Substances (PFAS) definition:

Any substance that contains at least one fully fluorinated methyl (CF₃-) or methylene (-CF₂-) carbon atom (without any H/Cl/Br/I attached to it).

Very wide definition, estimate 10,000 substances

Is in line with the OECD 2021 definition Includes:

Fluoropolymers



REGULATORY SITUATION: PFAS-FREE REQUIREMENTS

PFAS meaning

several thousands of per- and polyfluoroalkyl substances
low molecular weight
vs. polymeric materials
("processing aids")

EU-situation

an entire class of fluor-chemistry is being regulated
new regulations or restrictions expected in 2027 / 2028 food packaging films (e.g. PE and PP) are affected as well

USA-situation

total ban of PFAS in various states already implemented

brand owners

precautious move to eliminate PFAS started

TECHNICAL BASICS → CLASSIC PRE-COATING PROCEDURES

Picture 1
C6-mLLDPE
without PPA

Picture 2
C6-mLLDPE
with PPA

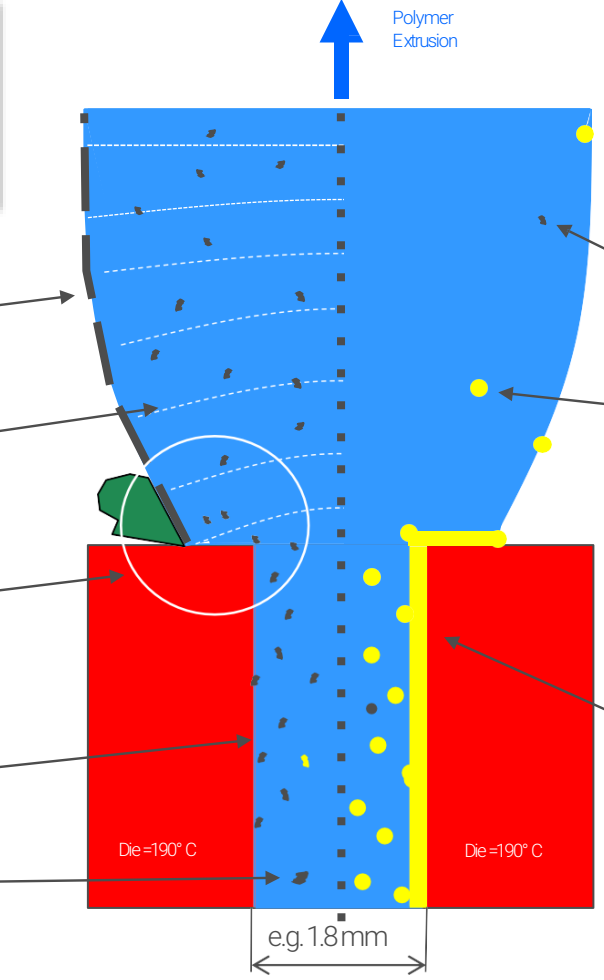
5. Surface Marks.

4. Melt Fracture.
„shark skin“

3. High shear zone:
- Die swell.
- Die buildup.

2. Metal surface not coated
- Deposits accumulate.

1. Specs & gels from screw:
- Carried forward into die.



Only very few specs left.

Inert PPA remains in film.

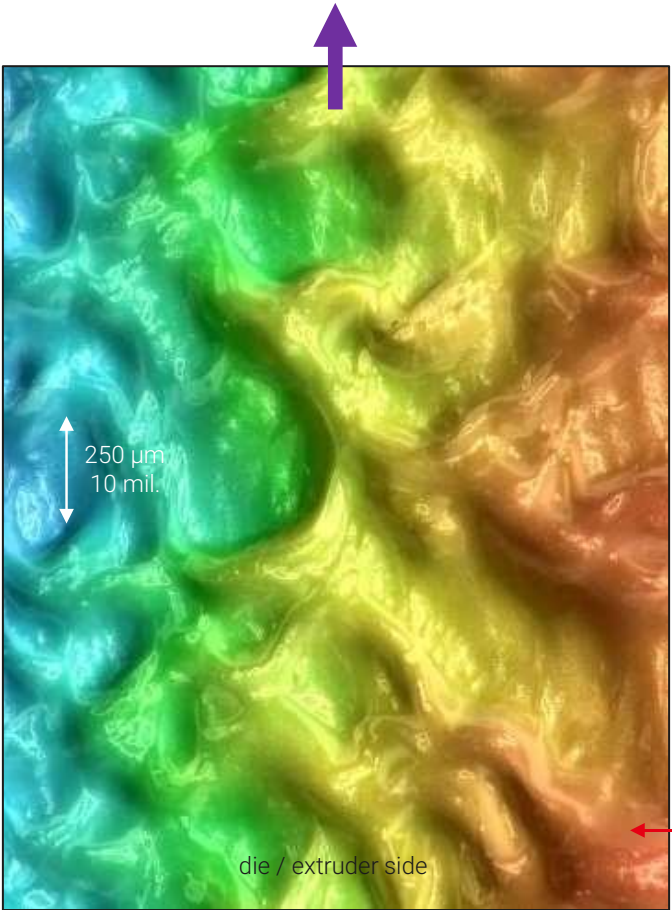
PRECOATING
15 min: ~ 10% batch. *Metal surface well coated: melt pressure stabilizes, no deposits accumulate!*

TECHNICAL BASICS → CLASSIC PFAS-BASED PORTFOLIO

+++ the best
 ++ good
 + it's OK
 0 no effect
 - don't use

	VERSATILE	EFFICIENT	HIGH END
	PA 00833 LD 1 st generation	PA 00856 LD (PA 001970) 2 nd generation	PA 00809 LD 3 rd generation
processing	max. 290° C	max. 240° C	max. 230° C
application	blown & cast film	blown film	blown film
die build-up	++	+++	++
melt fracture	++	++	+++
pressure reduct.	+++	++	++
some comments	PA 0H670 LL: >300° C possible.	Best with UV: > large portfolio.	PA 00810 LD: >235° C cast film.

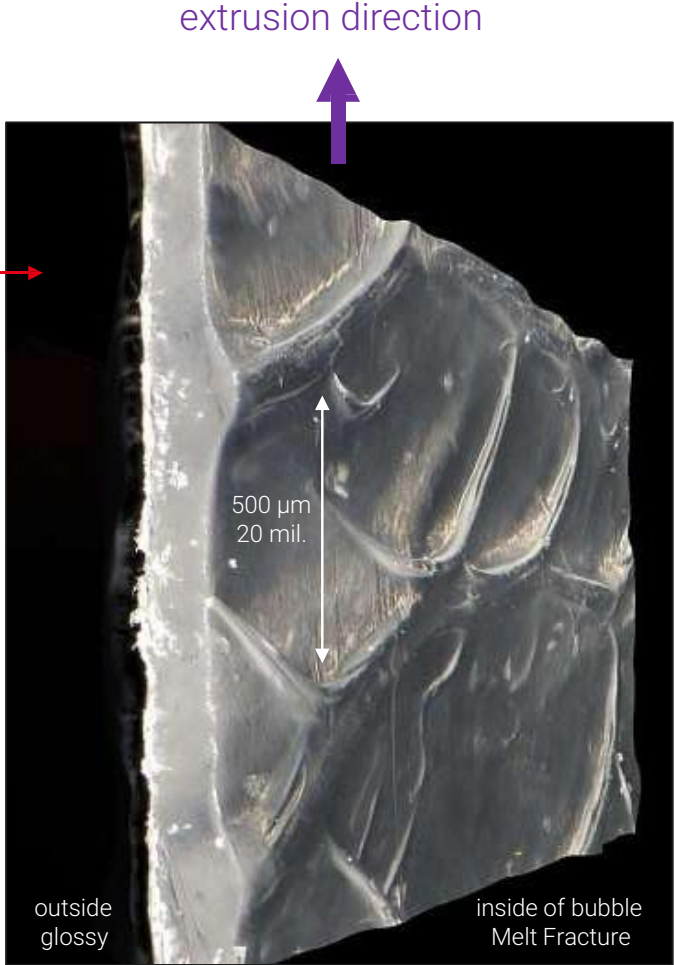
TECHNICAL BASICS → MELT FRACTURE



Melt die swell *in situ*, as it appears at a die exit.
Extreme die swell leads to a very rough melt (!) surface.

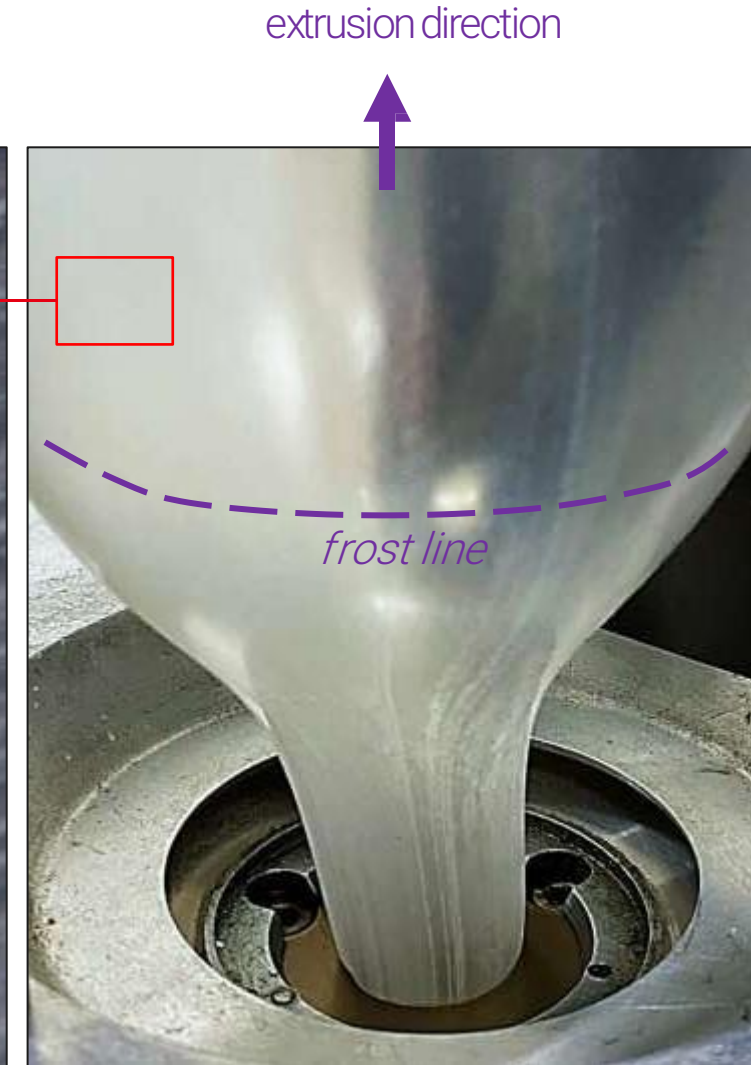
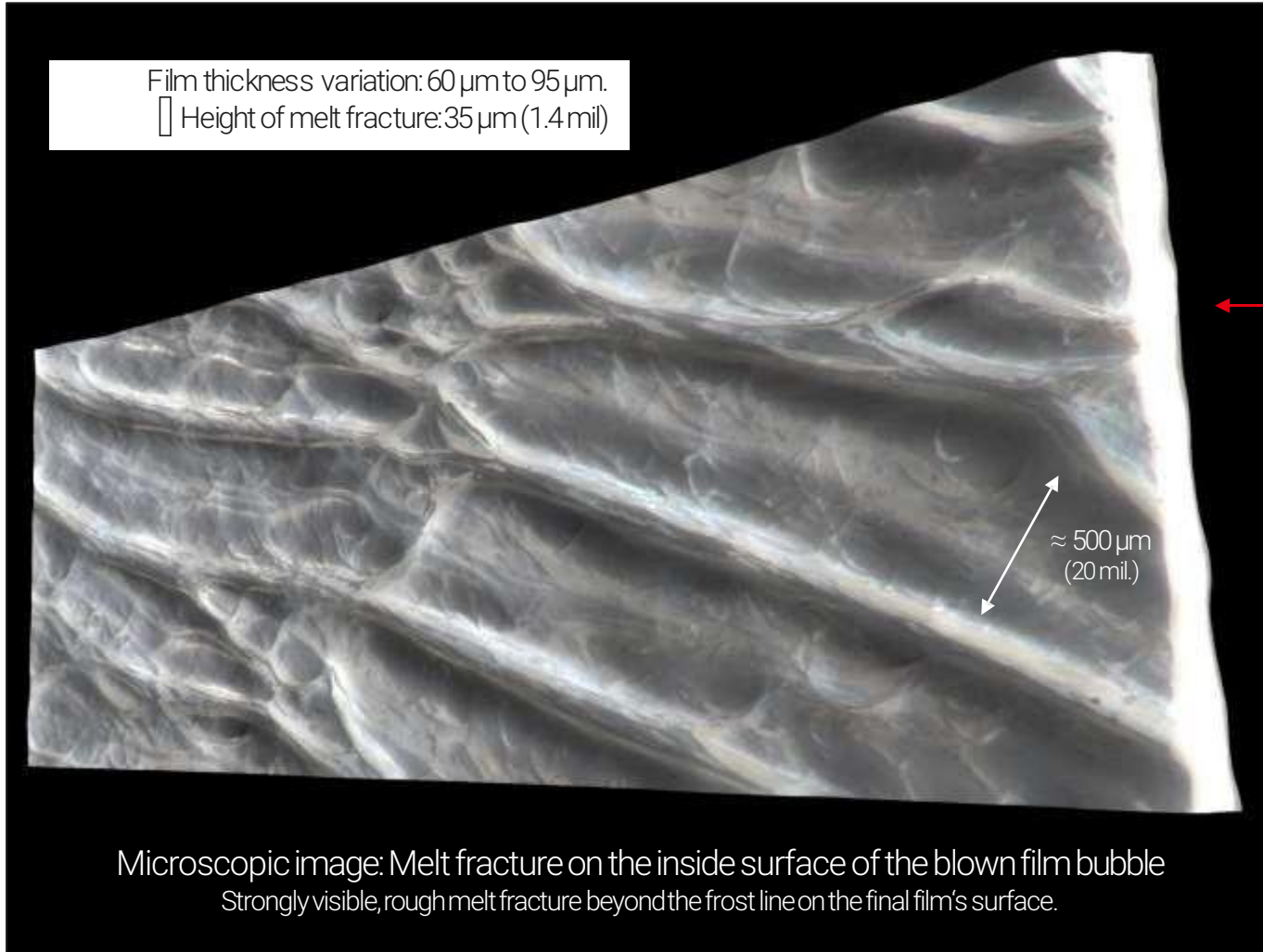


CONSTAB laboratory blown film: C4-Zn-LLDPE
5 kg/h, die 25 mm, gap = 0,2 mm, mono-layer 60 μm



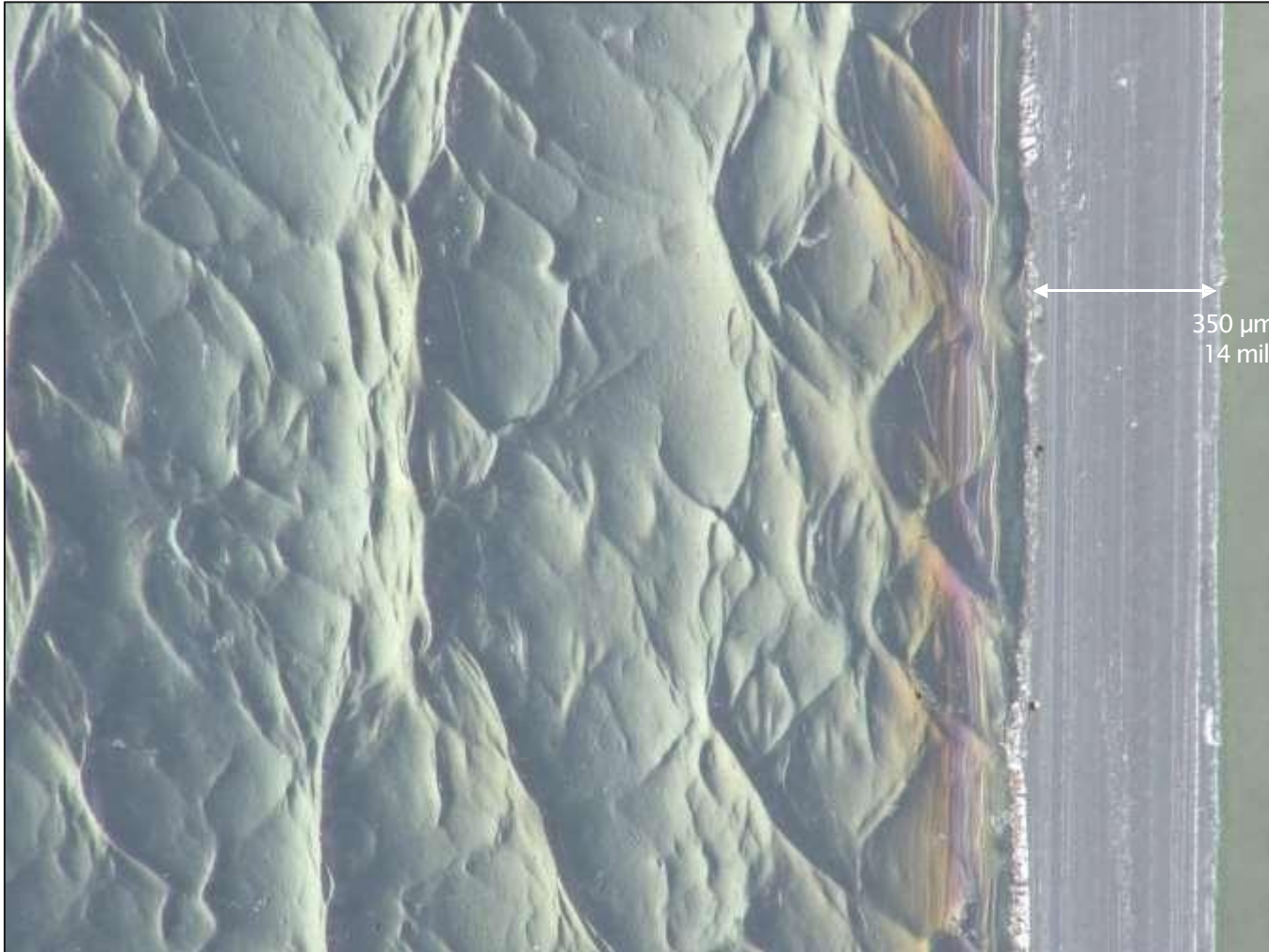
Melt fracture in the final film as a surface defect.
Die swell stretched with a blow-up ratio BUR = 1:3.

TECHNICAL BASICS → MELT FRACTURE



CONSTAB laboratory blown film: C4ZnLLDPE
 5 kg/h, die 25 mm, gap = 0.2 mm, mono-layer 60 μm
 11 lbs per hour, die diameter 1 inch, die gap 8 mil, film thickness 2.4 mil.

TECHNICAL BASICS → INTERFACIAL INTERFERENCE / INSTABILITY



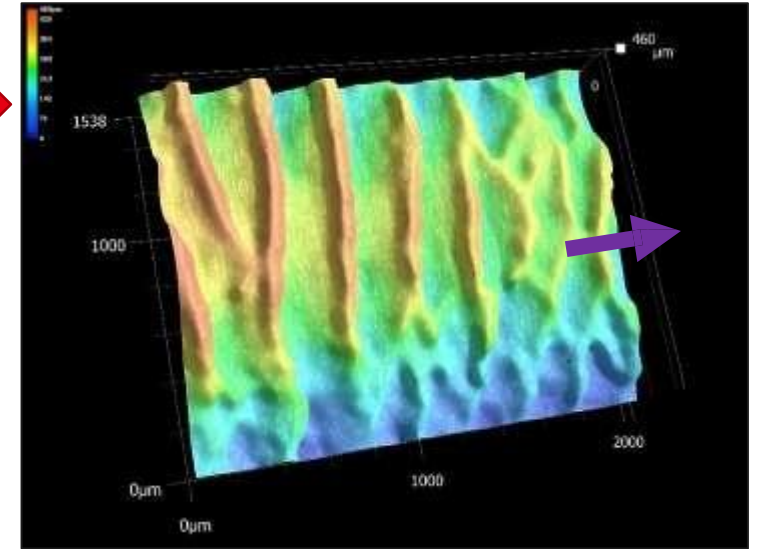
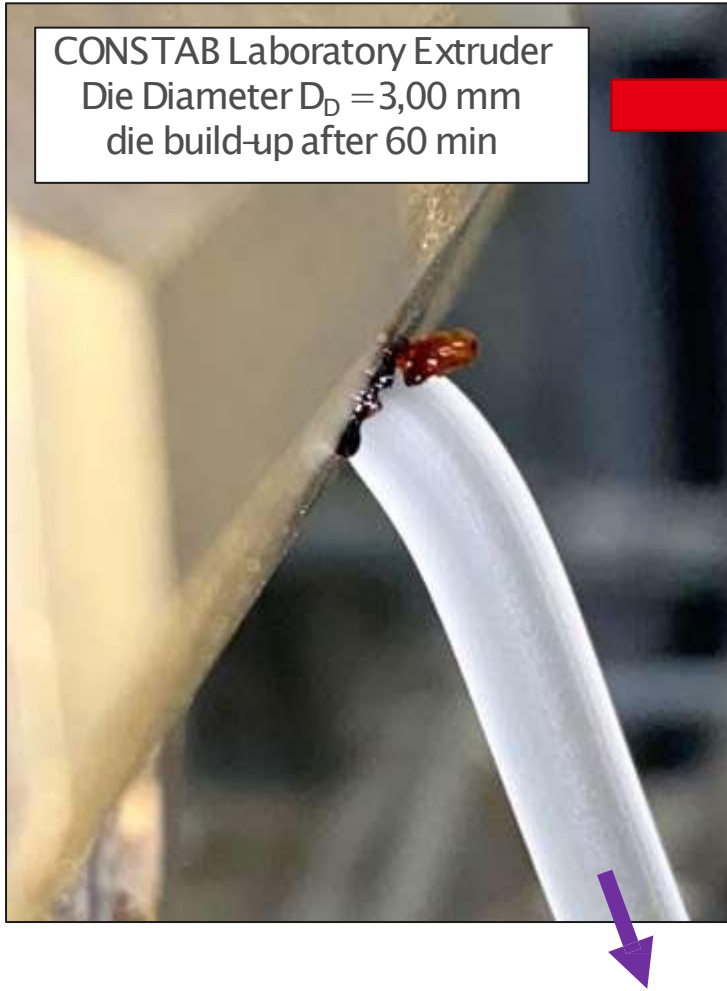
Industrial Trial Set-Up:

- 3-layer blown film → output 400 kg/h
- C6-mLLDPE in skin layers → LDPE in core
- total final (!) film thickness 65 μm

Microscopic image left: Interfacial Instability Unstretched melt surface, collected from the die gap during the start up phase of an extrusion production.

Conclusion: The „roughness“ visible in this test is not classic surface melt fracture, but a melt viscosity induced flow irregularity, occurring between skin and core layer, within the extrusion line's die head. The film's surface is smooth and glossy; no mechanical surface roughness is detectable on this film.

TECHNICAL BASICS → DIE SWELL / PRESSURE REDUCTION

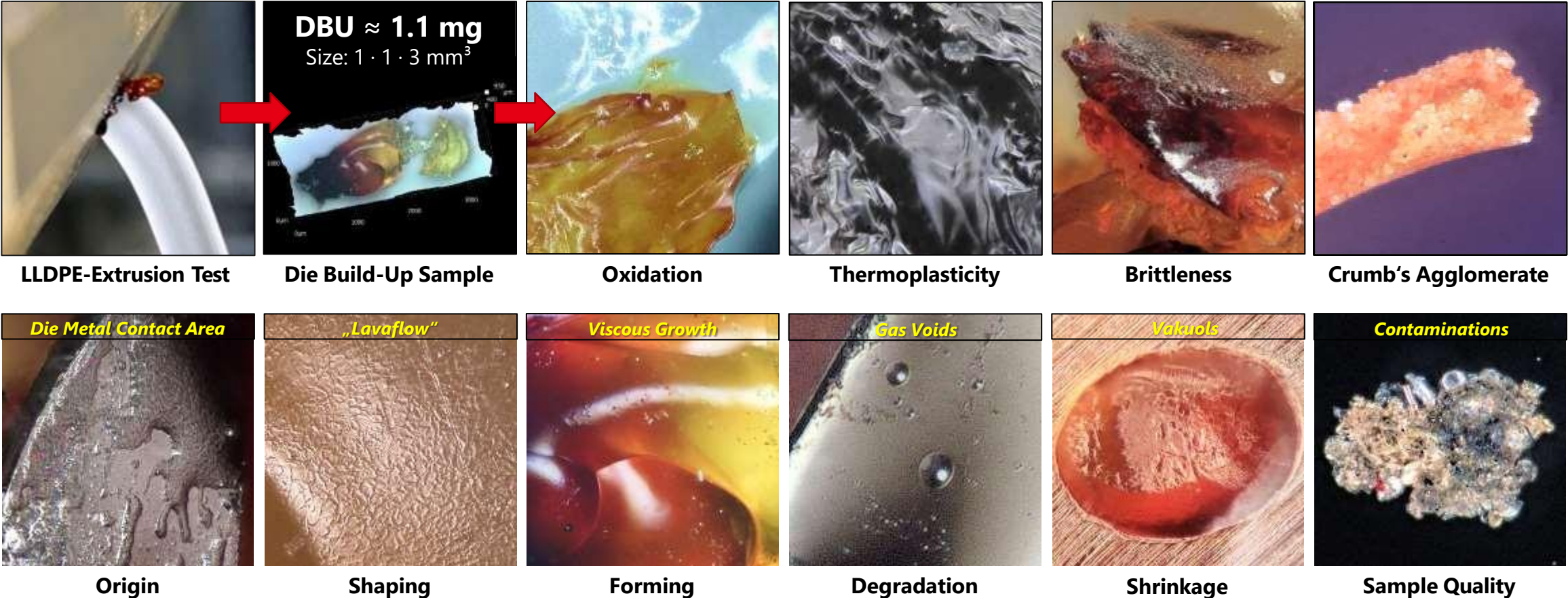


Melt Fracture Surface Geometry
Output = 5 kg/h → 5.279 cm³/h
 $D_O \approx 4,50$ mm / $D_I \approx 3,75$ mm
Groove Height • $\approx 0,375$ mm
Groove Distance • $\approx 0,35$ mm
Groove Frequency • ≈ 333 s⁻¹

extrusion direction

TECHNICAL BASICS → DIE BUILD-UP / DIE DEPOSIT

Images below illustrate details of one single piece of DBU (top left), collected from a CONSTAB laboratory extrusion line:
 The information gathered from these pictures helps us to understand the nature of DBU's chemistry and physics. CONSTAB PFAS-free processing aid masterbatches are being developed based on findings from such fundamental research activities performed by a global team of experts within the KAFRIT-group.



PROCESSING AID RELEVANCE

→ Priority: Melt Fracture Reduction

Classic Fluoropolymer

PA 00856 LD	235 °C (455 °F)
PA 00804 LD	235 °C (455 °F)
PA 00805 LD	290 °C (555 °F)

New PFAS-Free Development

PA 00892 LD	235 °C (455 °F)
CON-X PA 892 PE	255 °C (490 °F)

High quality blown film without visible melt fracture surface defects.



dosage: 1.0 % up to 2.0 %
available QT-3 2023

EC and FDA Food approval . Lowest odour and best organoleptic properties.

PROCESSING AID RELEVANCE

→ Priority: DIE BUILD-UP REDUCTION

Classic Fluoropolymer

PA 00833 LD	290 °C (555 °F)
PA 00810 LD	300 °C (570 °F)
PA 00852 LD	310 °C (590 °F)

New PFAS-Free Development

PA 00893 LD	255 °C (490 °F)
CON-X PA 893 PE	310 °C (590 °F)

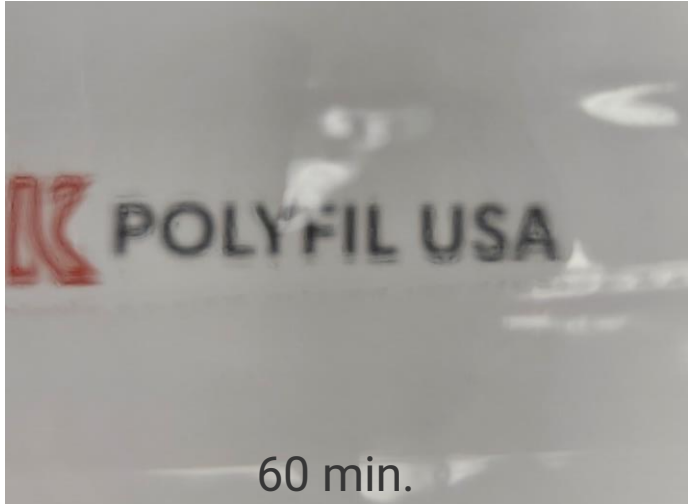
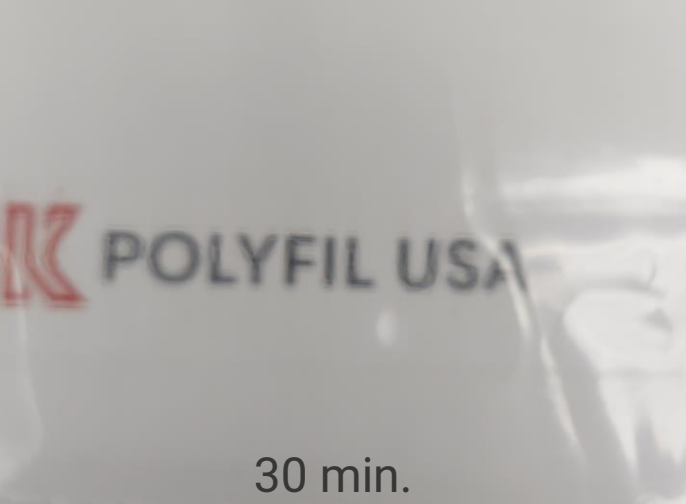
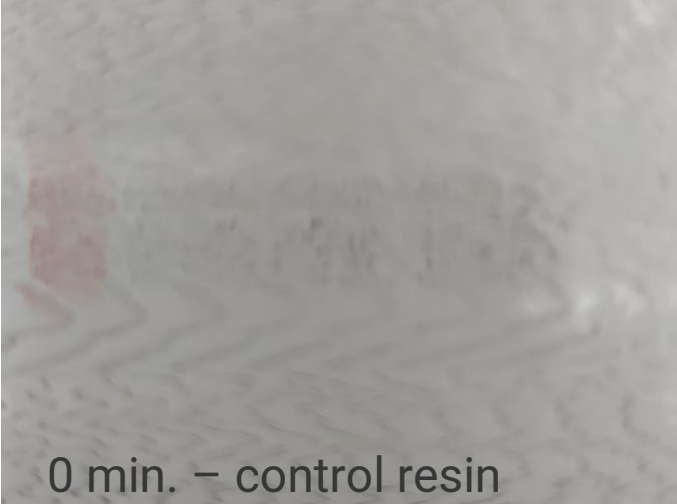
Perfectly clean die head without die-build up at the start of a new production.



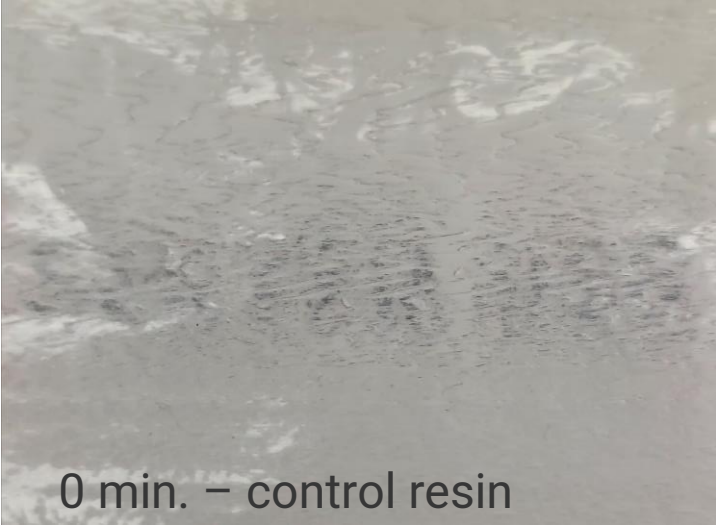
dosage: 0.5 % up to 2.0 %
available QT-3 2023

EC and FDA Food approval . Avoids gel formation . Best with recyclate.

PAC-0005FFLL-G: MELT FRACTURE STUDY (3% DOSING RATIO)



PAC-0005FFLL-G: MELT FRACTURE STUDY (0.5% DOSING RATIO)



PROCESSING AID RELEVANCE

→ Priority: DIE REDUCTION

Classic Fluoropolymer

PA 00856 LD	235 °C (455 °F)
PA 00809 LD	235 °C (455 °F)
PA 00805 LD	290 °C (555 °F)

New PFAS-Free Development

PA 00893 LD	255 °C (490 °F)
PA 00899 LD	275 °C (525 °F)

Extreme extrusion die exit flow marks due to high wall shear stress.



dosage: 0.5 % up to 2.0 %
dosage: 2.5 % up to 10.0 %

EC and FDA Food approval . Best for highly filled, low viscosity applications.

SUMMARY

Classic Processing Aids (PFAS-based)

Most efficient benchmarks since 1985.

New PFAS-Free Developments

All blown and cast film extrusion.

Industrial- & Food Packaging Films

First commercial applications in 2022.

Outlook into the Future

Technical & Regulatory Optimization.



PA 00892 LD / PA 00893 LD / PA 00899 LD
CON-X PA 892 LD / CON-X PA 893 LD



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