

POSS[®] Overview and Applications



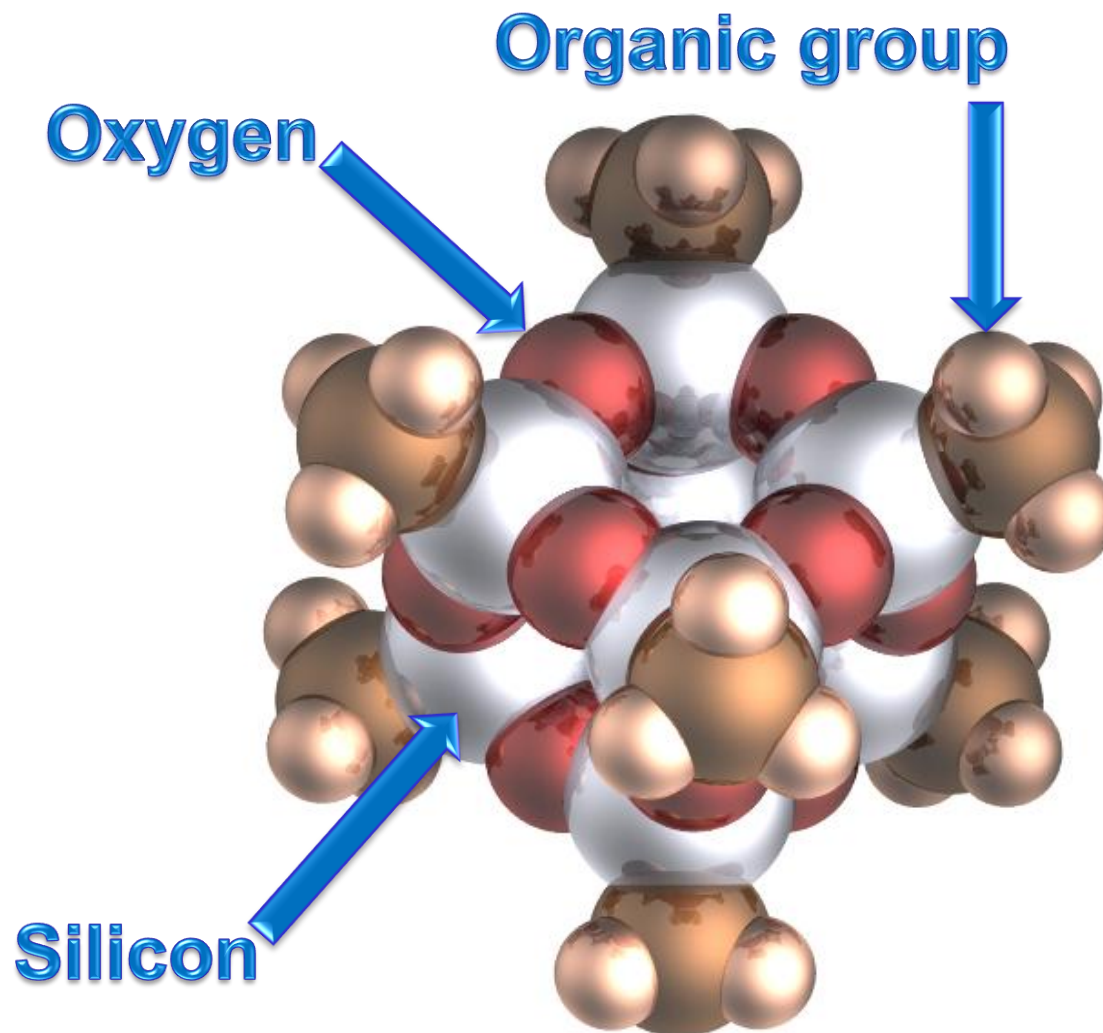
Dr. Chris DeArmitt FRSC
Chief Scientist

Hybrid Plastics Inc.
Hattiesburg, MS
USA

Overview

- What is POSS®?
- POSS® Flow Aids
- Dispersants for Pigments & Fillers
- Pricing and Availability
- POSS® production and safety
- Conclusions

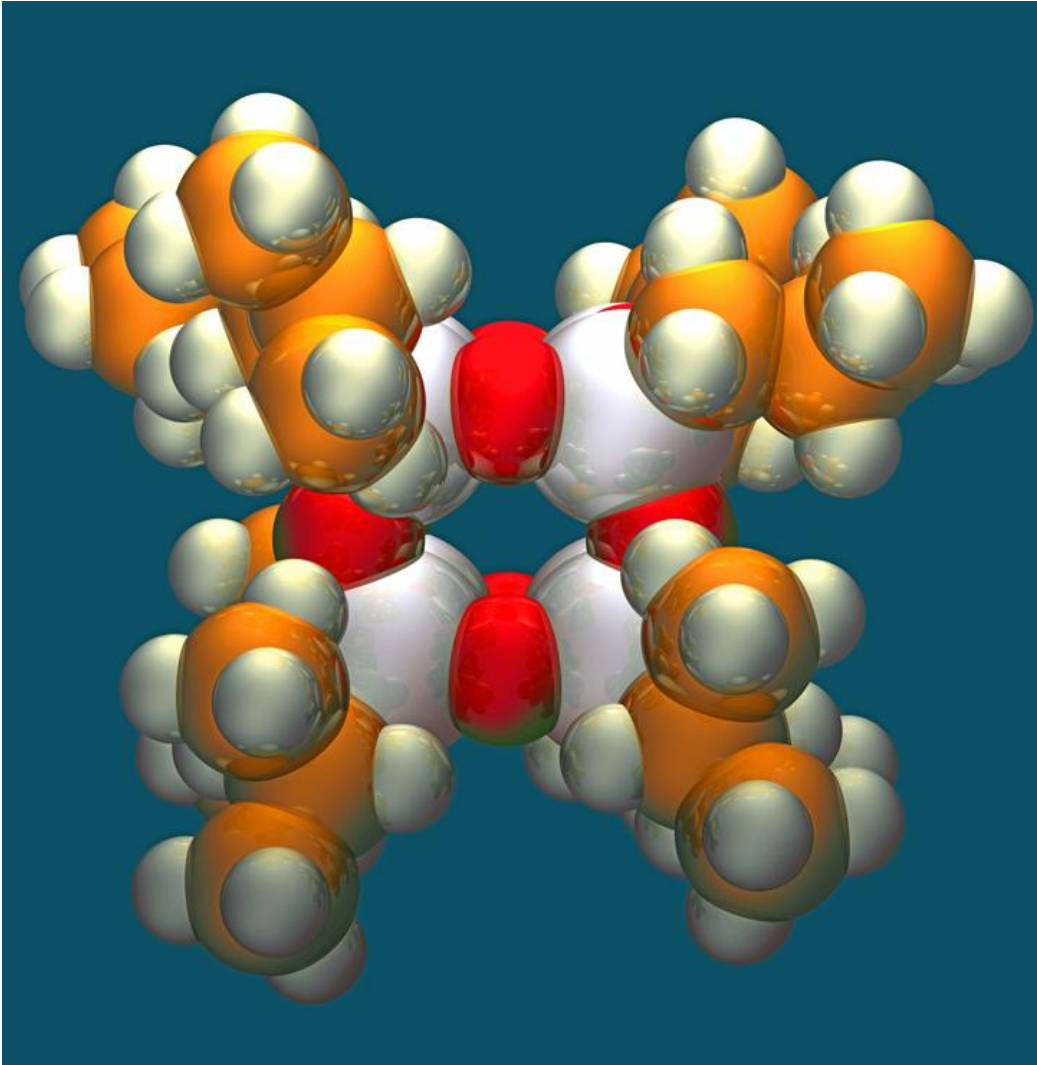
POSS[®] Molecular Structure



Organic Groups

- Silane (-Si-H)
- Methyl
- Ethyl
- iButyl
- iOctyl
- Phenyl
- Acrylate
- Methacrylate
- Epoxy
- Vinyl
- Fluoroalkyl
- Alcohols
- Amines
- Thiols
- Carboxylic acid
- Sulfonic acid
- PEG/PEO
- etc...

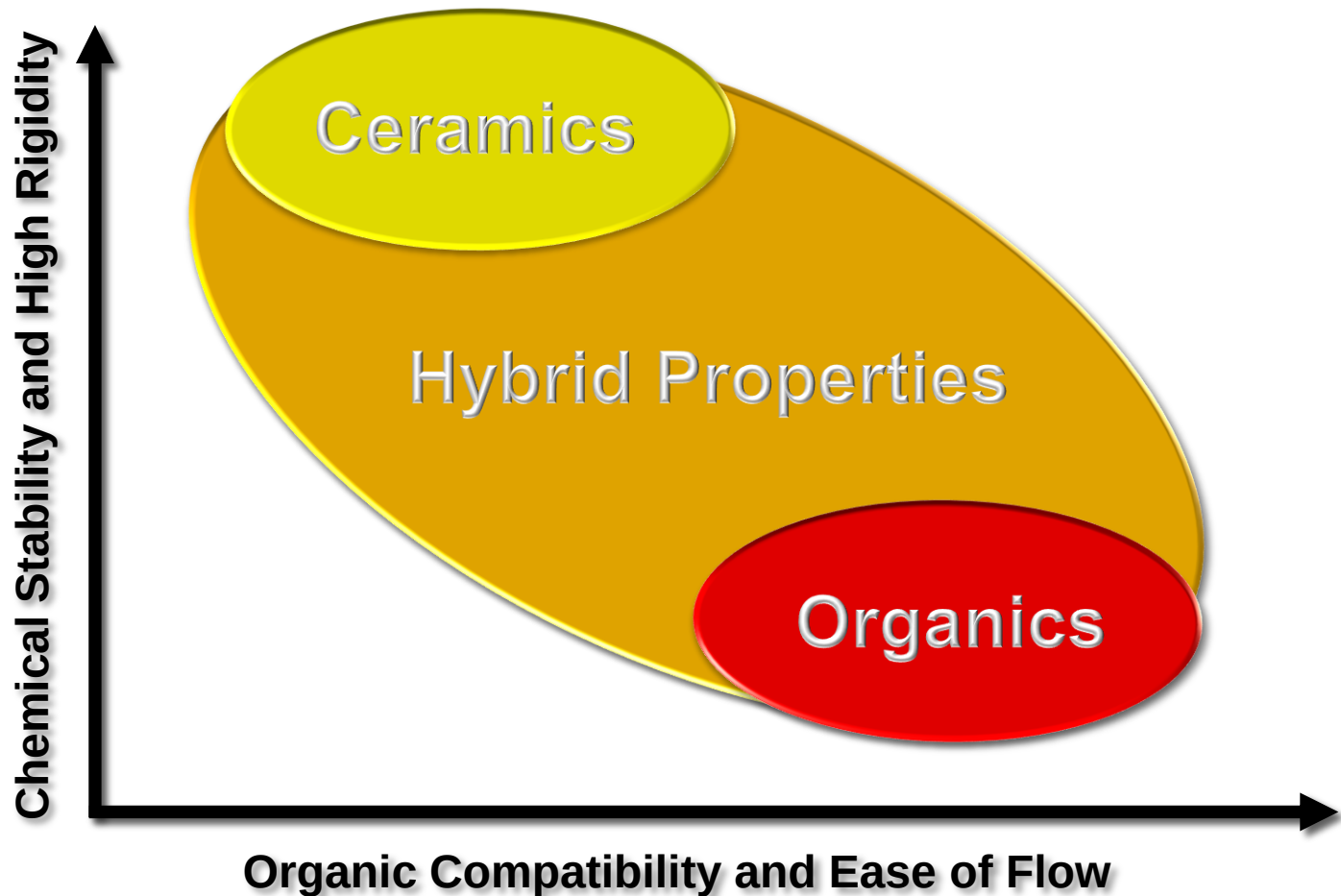
POSS[®] in Brief



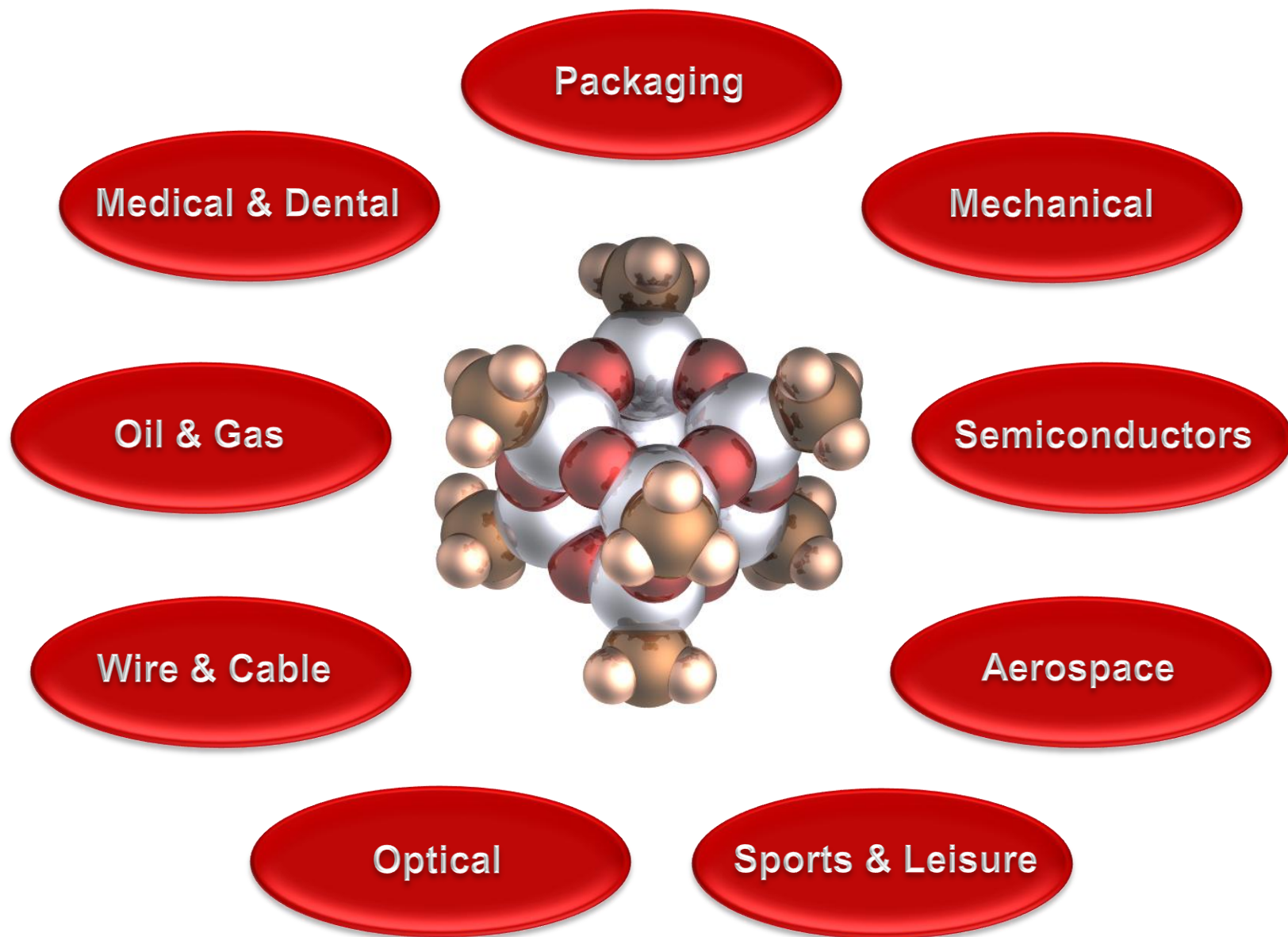
- Molecular filler
- Dissolves
- High stability
- High rigidity
- Customizable
- Reactive versions (epoxy, acrylate etc.)
- Safe
- Scaled-up and cost-effective
- Flow aids, dispersants, friction reduction etc.

Why Hybrid Materials?

POSS[®] is a **unique** hybrid organic-inorganic composition

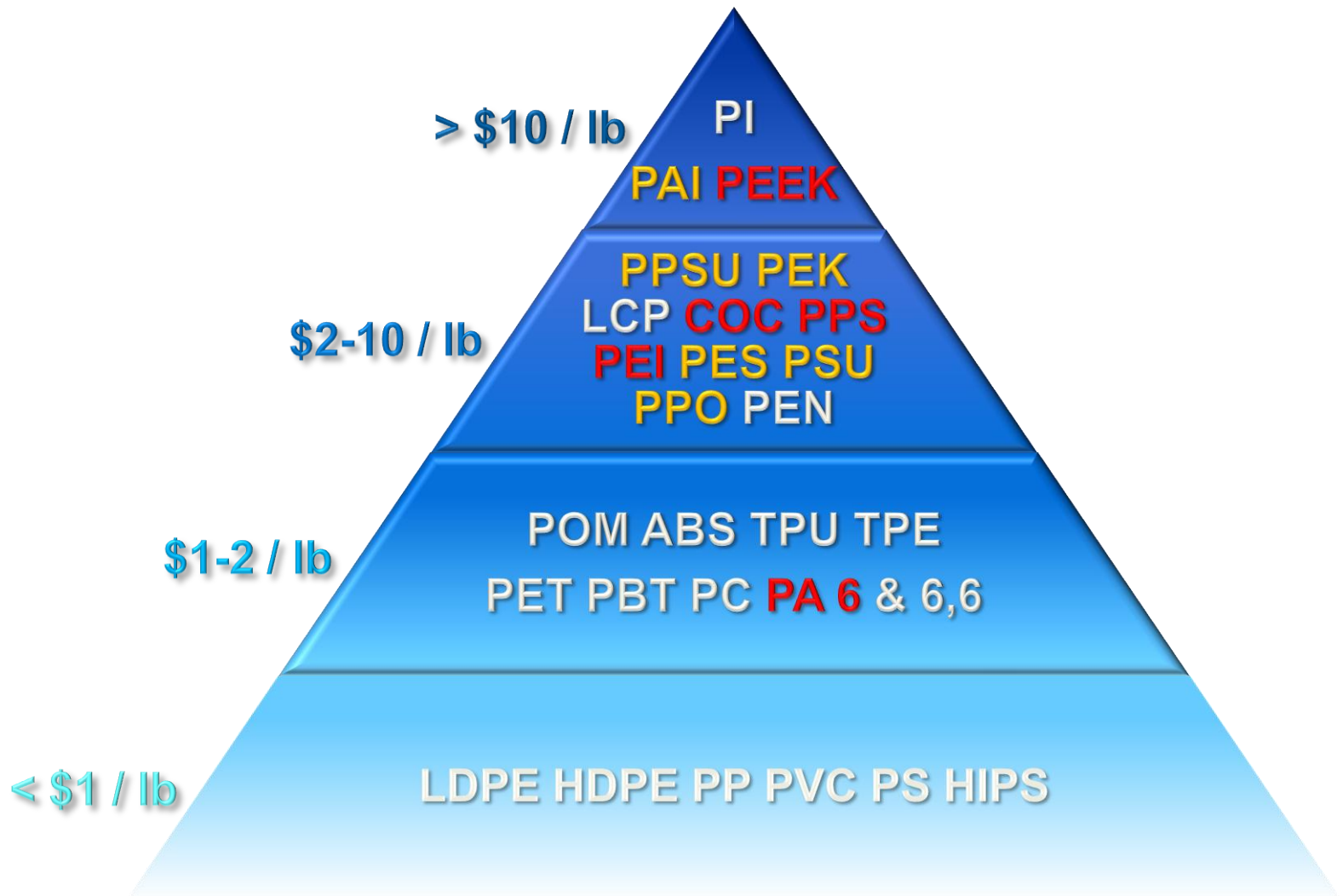


What can POSS[®] do for you?



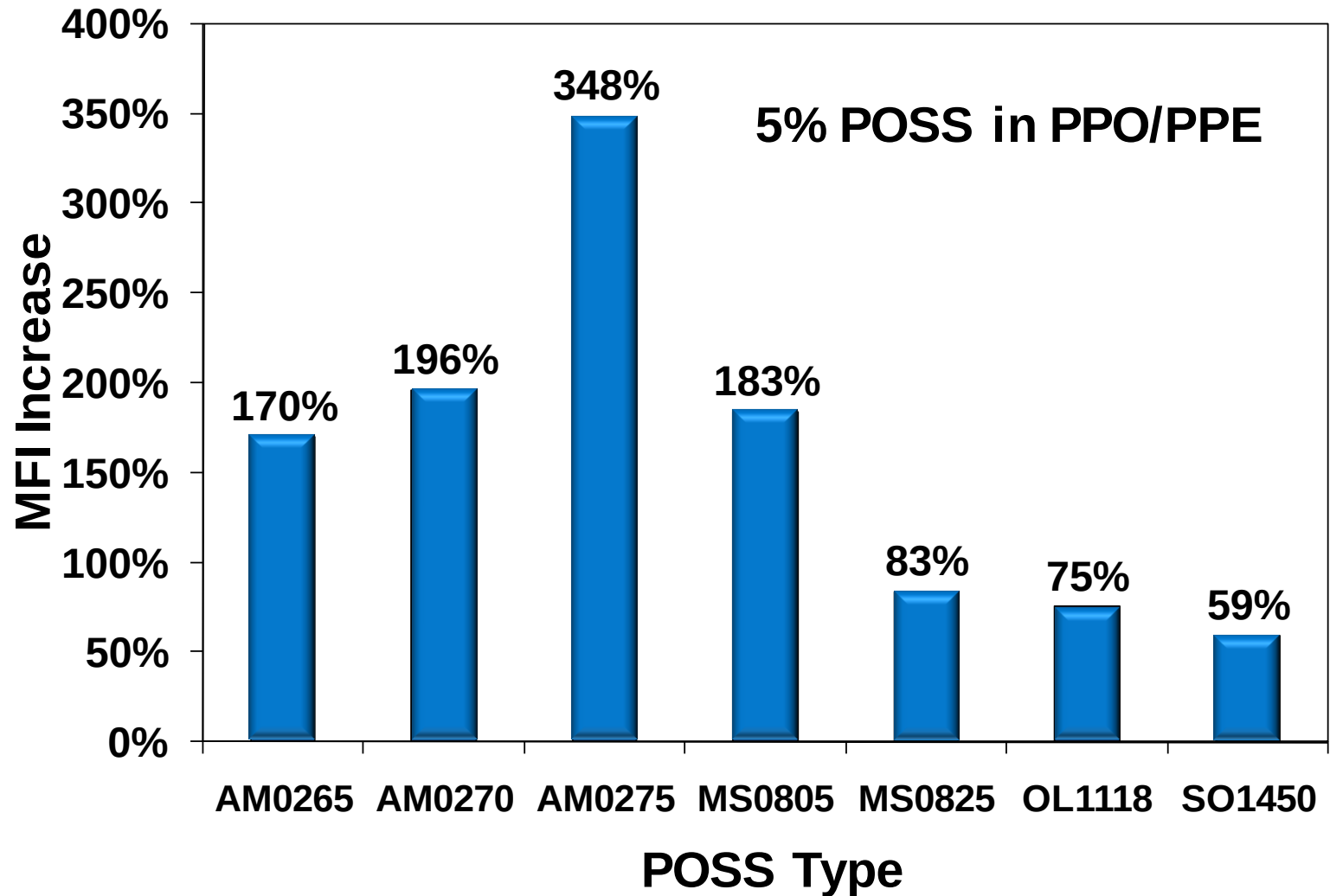
POSS[®] Flow Aids

POSS[®] Thermoplastics Commercialization



Reported Under development Commercial

Flow Enhancement in PPO/PPE



POSS[®] Flow in PPO / PPE



Neat PPO - translucent



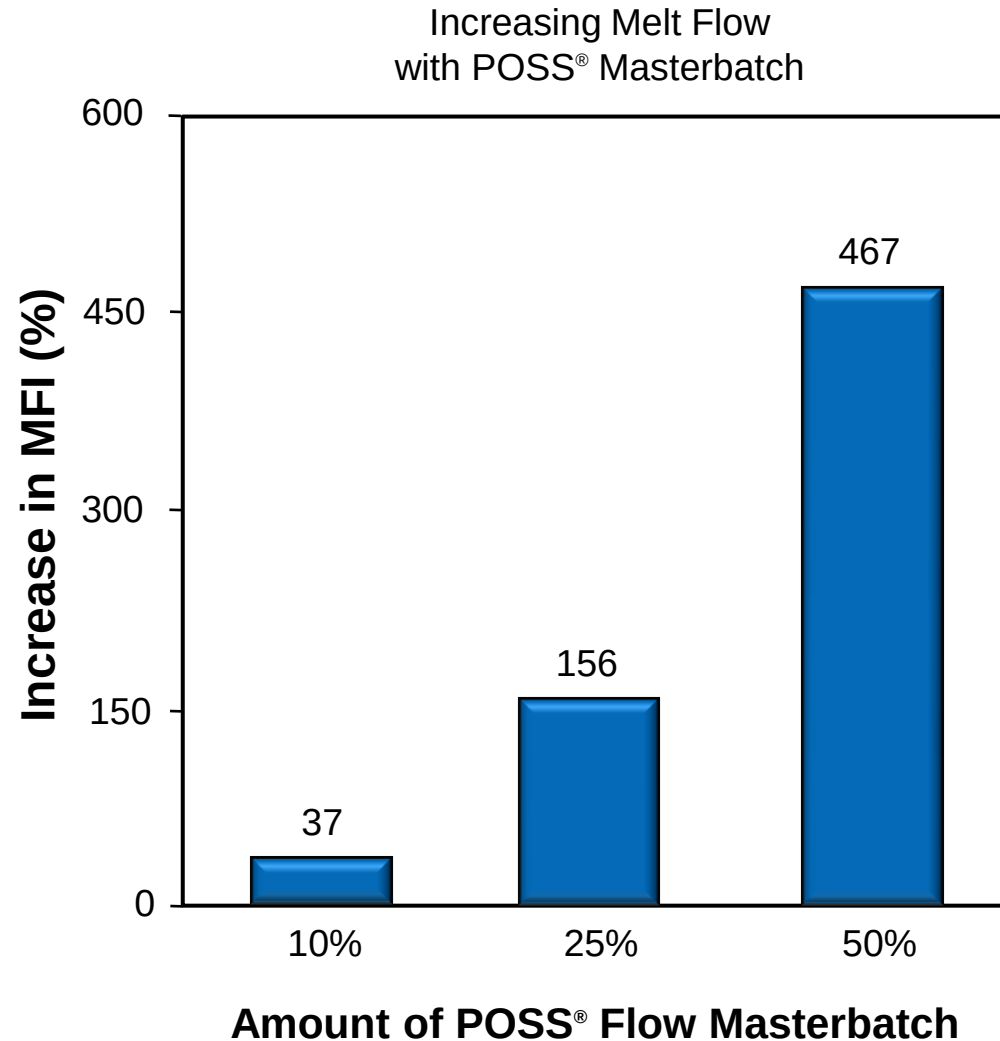
PPO with silicone - opaque



PPO with POSS - transparent, less color

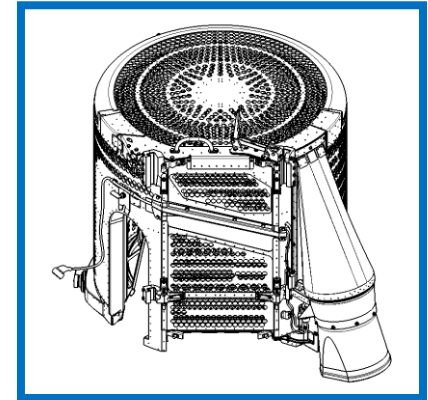
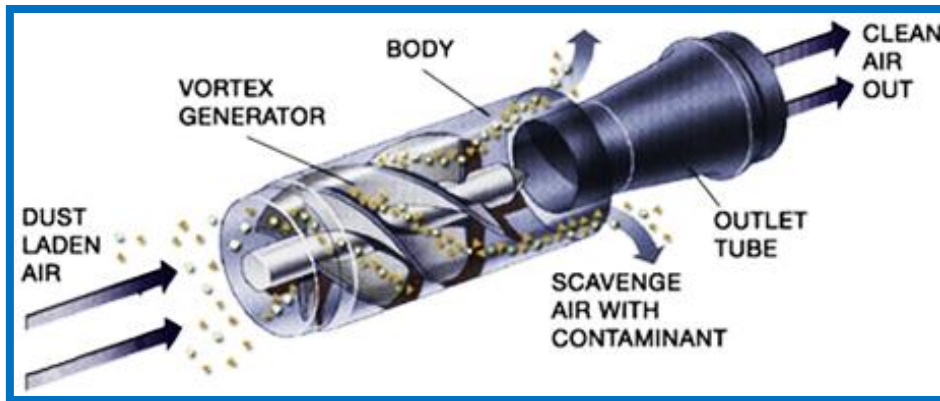
Ikeda & Saito. Reactive & Functional Polymers 67 (2007) 1148–1156

Flow Enhancement in COC with POSS[®]



260°C 2.16kg Topas[®] 6013 MFI 9g / 10min

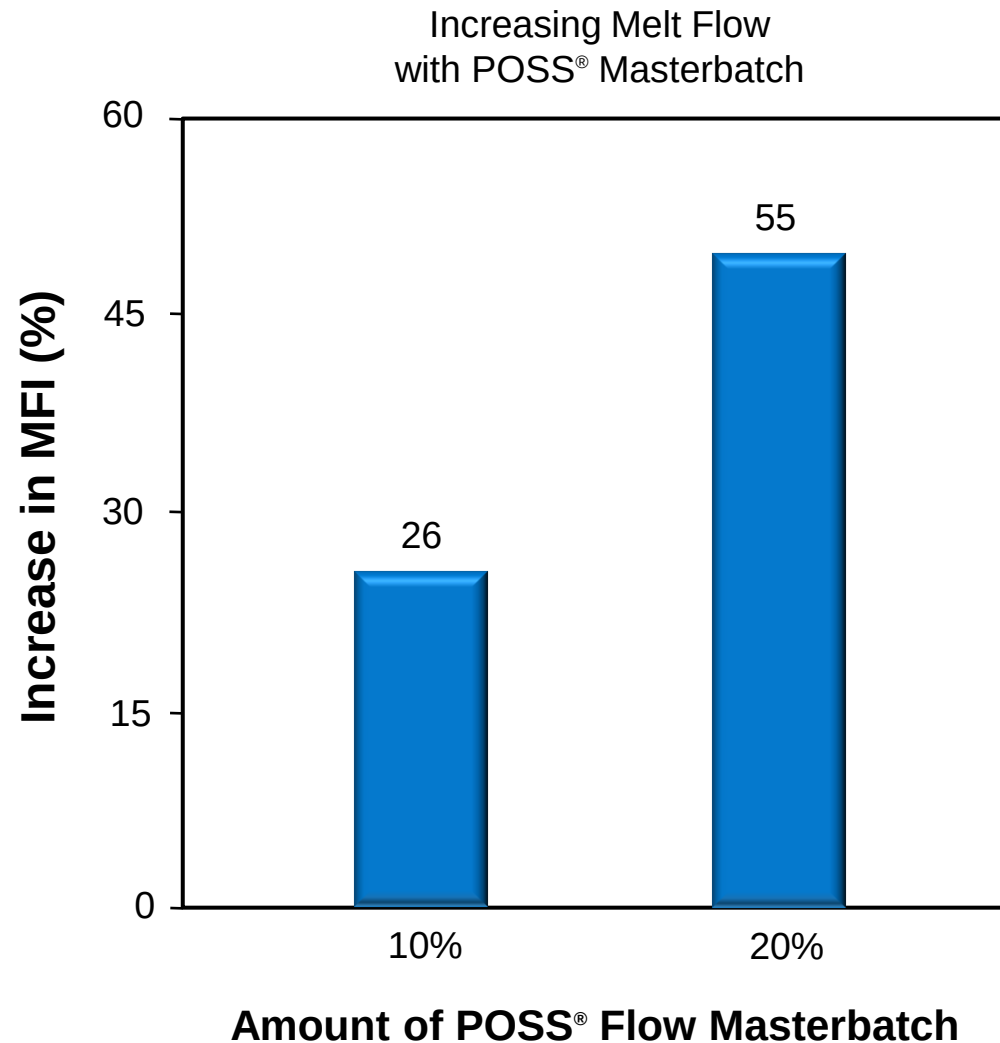
Vortex Separator Tube



POSS[®] Enhanced Cyclic Olefin Copolymer

- POSS[®] needed to mold thin-walled part
- Weight reduction (30%) compared to GF/FR PP
- Retained mechanical & thermal performance
- Improved anti-icing
- Reduced dust build-up
- Increased operating temperature range

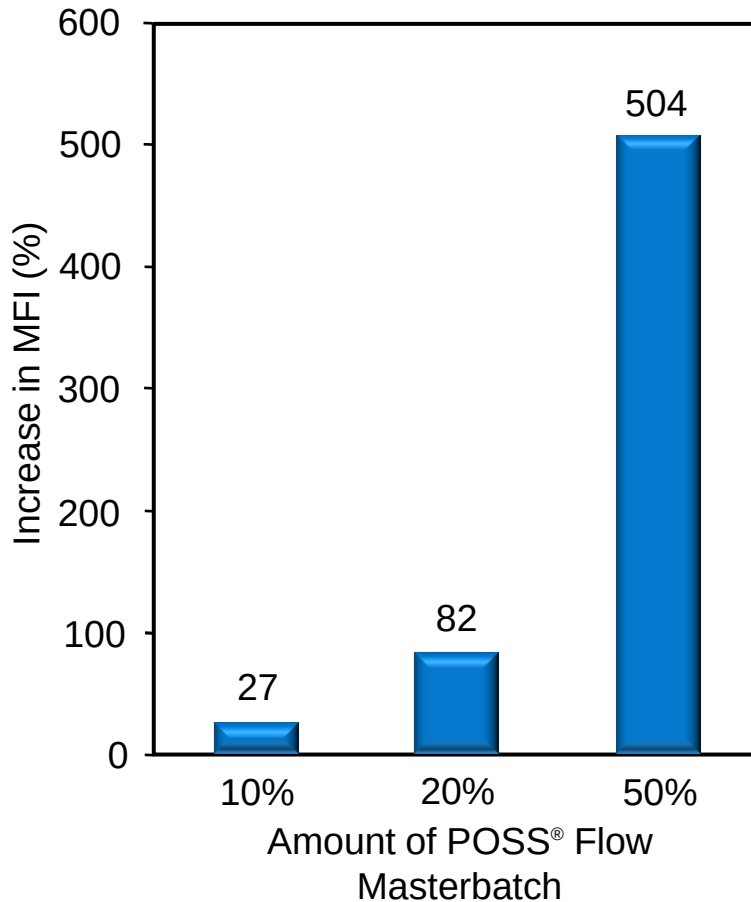
POSS[®] Flow PA6 Masterbatch



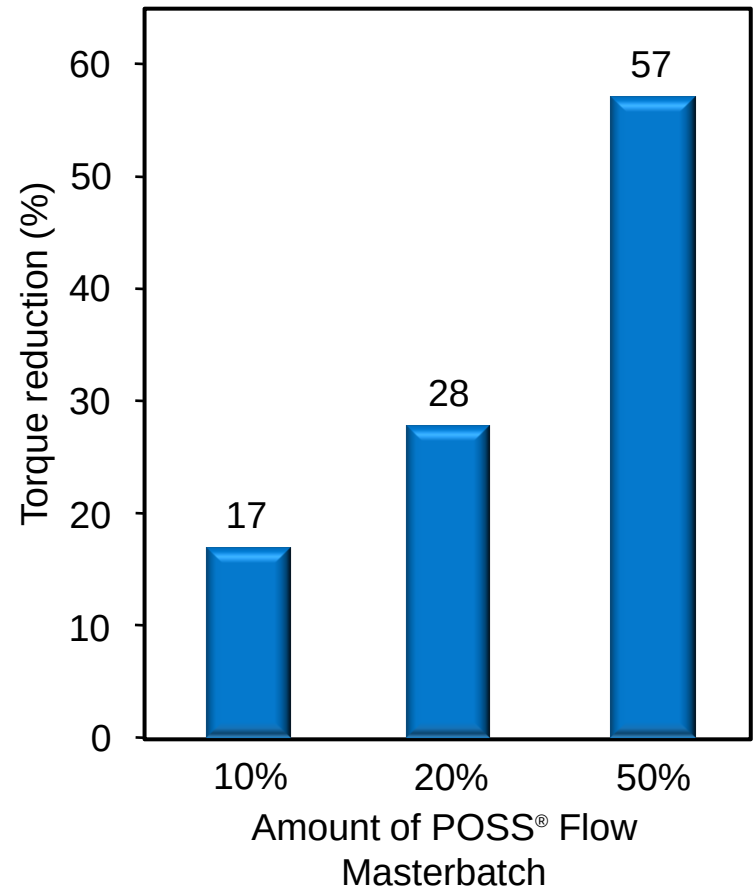
180°C 2.16kg PA6

POSS[®] Flow PEEK Masterbatch

Increasing Melt Flow
with POSS[®] Masterbatch

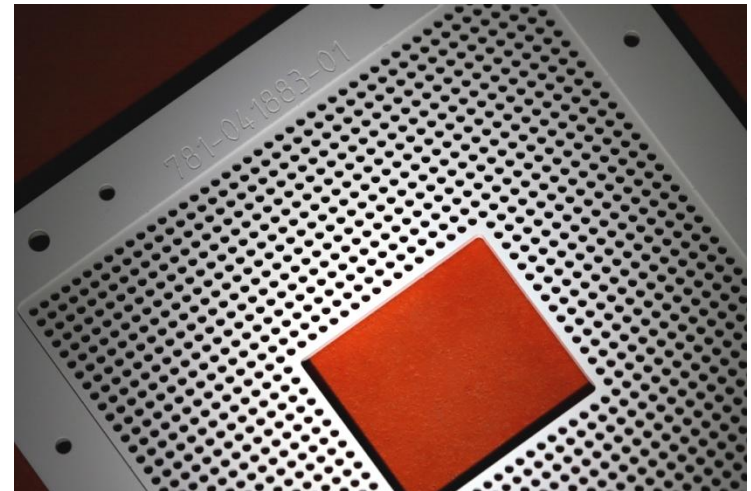
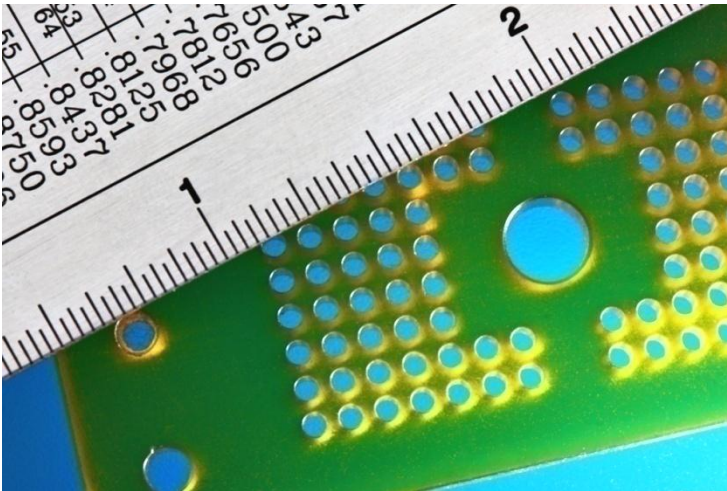
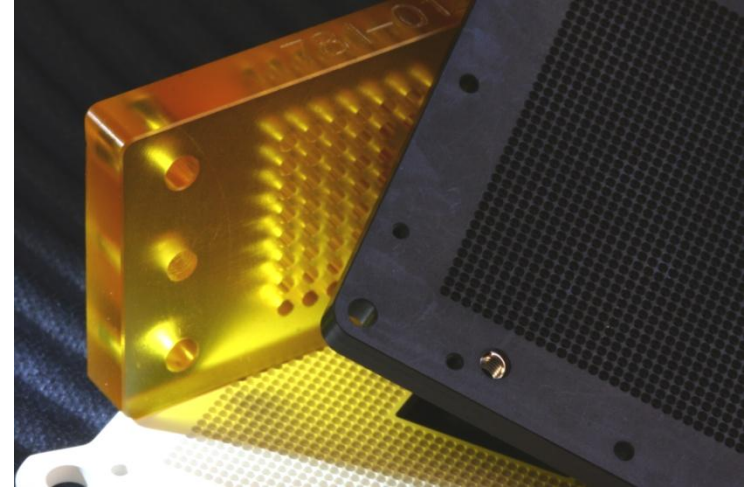
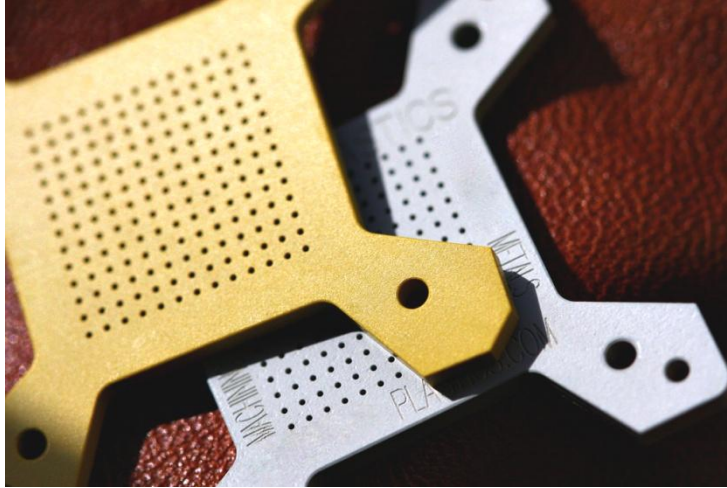


Decreasing Extruder Torque
with POSS[®] Masterbatch

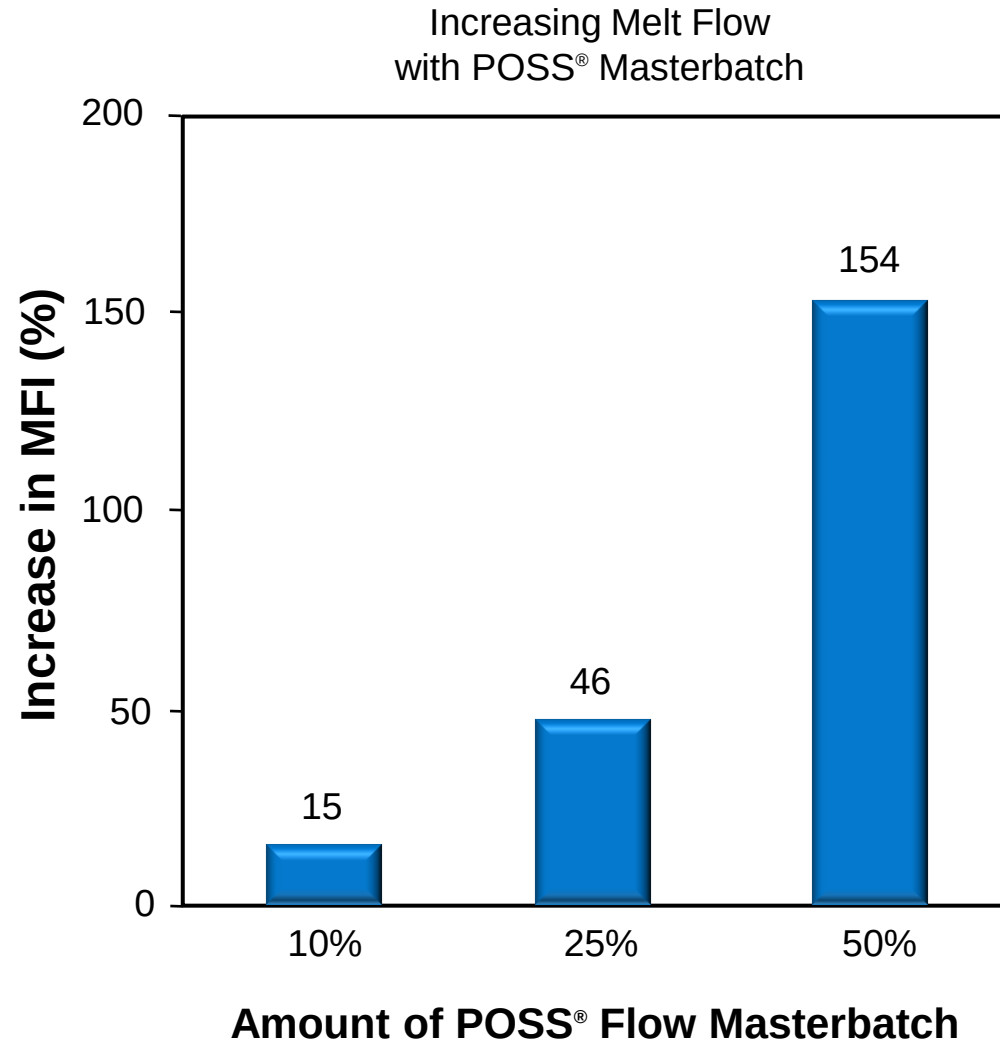


315°C 5.0kg Vestakeep[®] 4000P MFI 12g / 10min

POSS[®] Flow Aids for Complex Parts

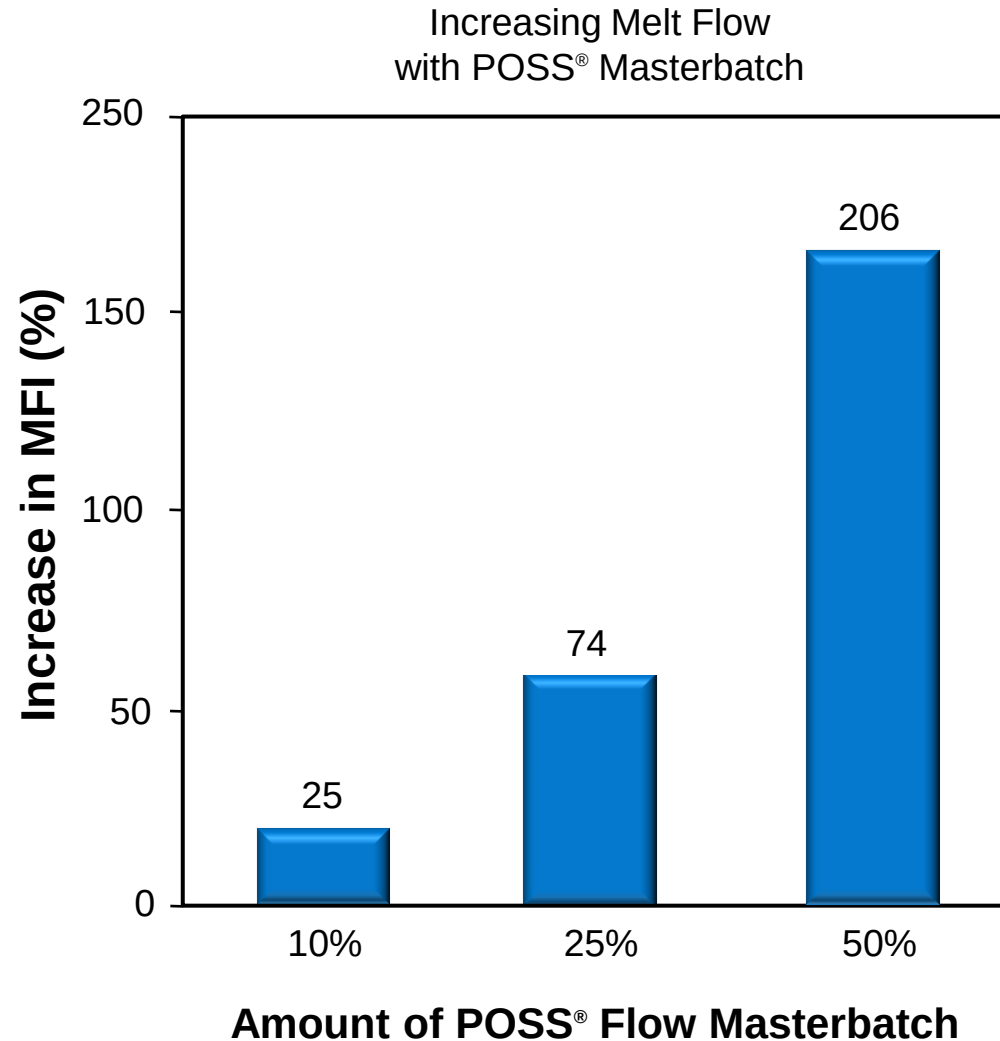


POSS[®] Flow PEI Masterbatch



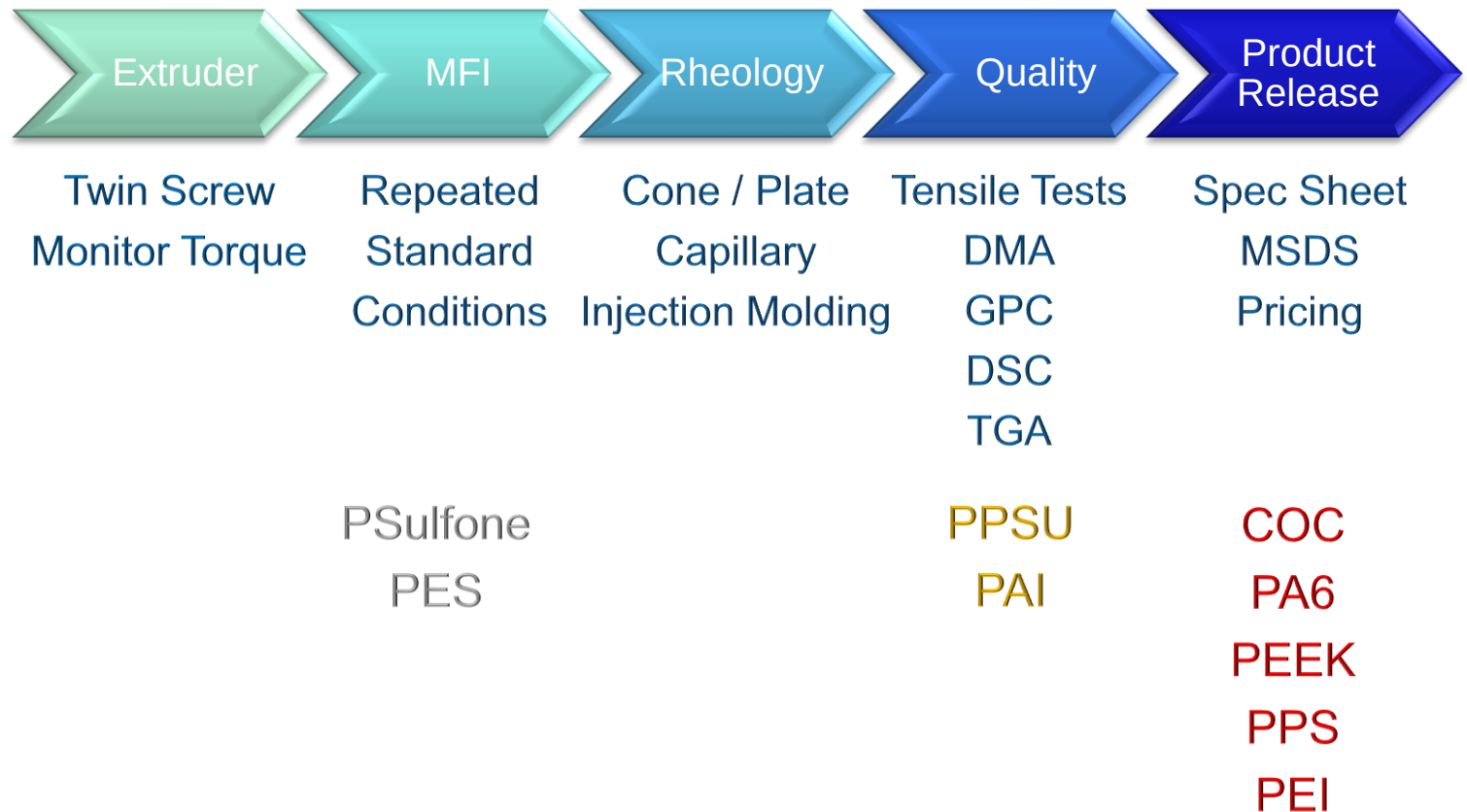
315°C 5.0kg Ultem[®] 1000P MFI 13g / 10min

POSS[®] Flow PPS Masterbatch



315°C 5.0kg Fortron[®] 0300 MFI 69g / 10min

POSS® Flow Development Scheme



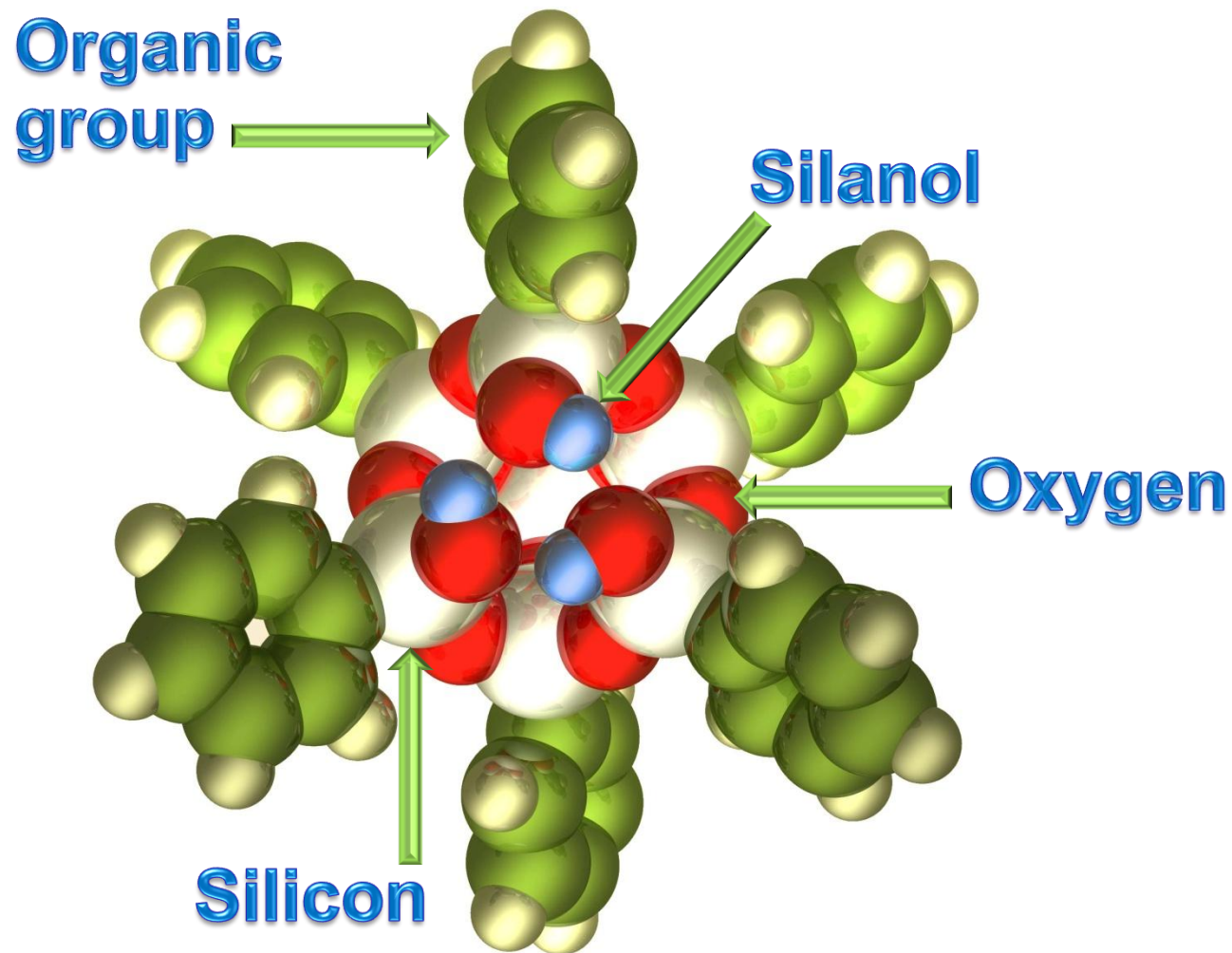
Why use POSS[®] Flow Aids?

- Drop in solution
- Enhanced flow / processability
- Enables complex or thin-walled parts
- Facilitates mold-release
- Improve aesthetics (e.g. gloss & color)
- Lower processing temperatures
- Retained mechanical properties
- Wide range of polymers:

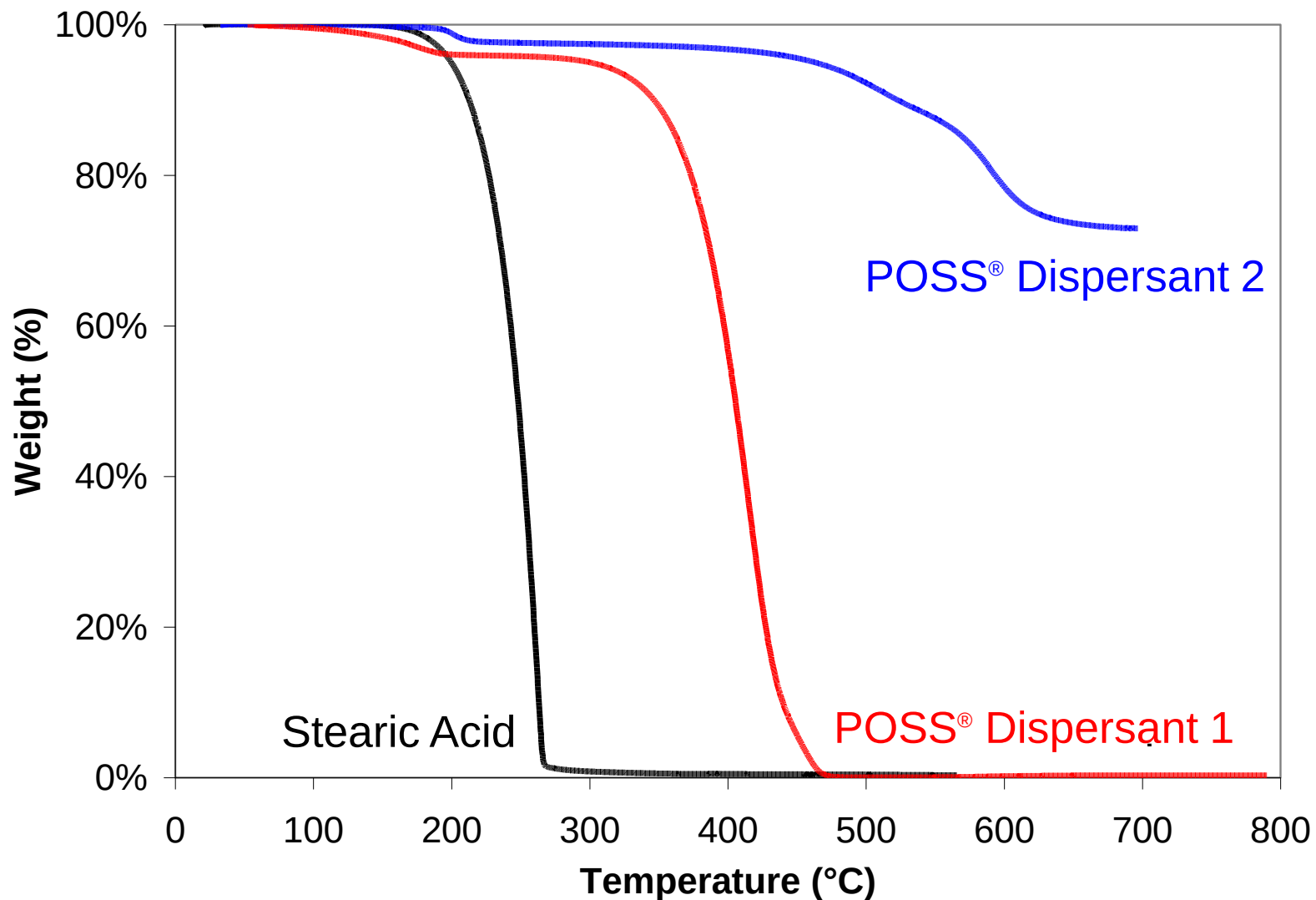
PPO, Nylon 6, COC, PEEK, PPS, PPSU, PEI,
and more on the way...

POSS[®] Dispersants

POSS[®] Trisilanol

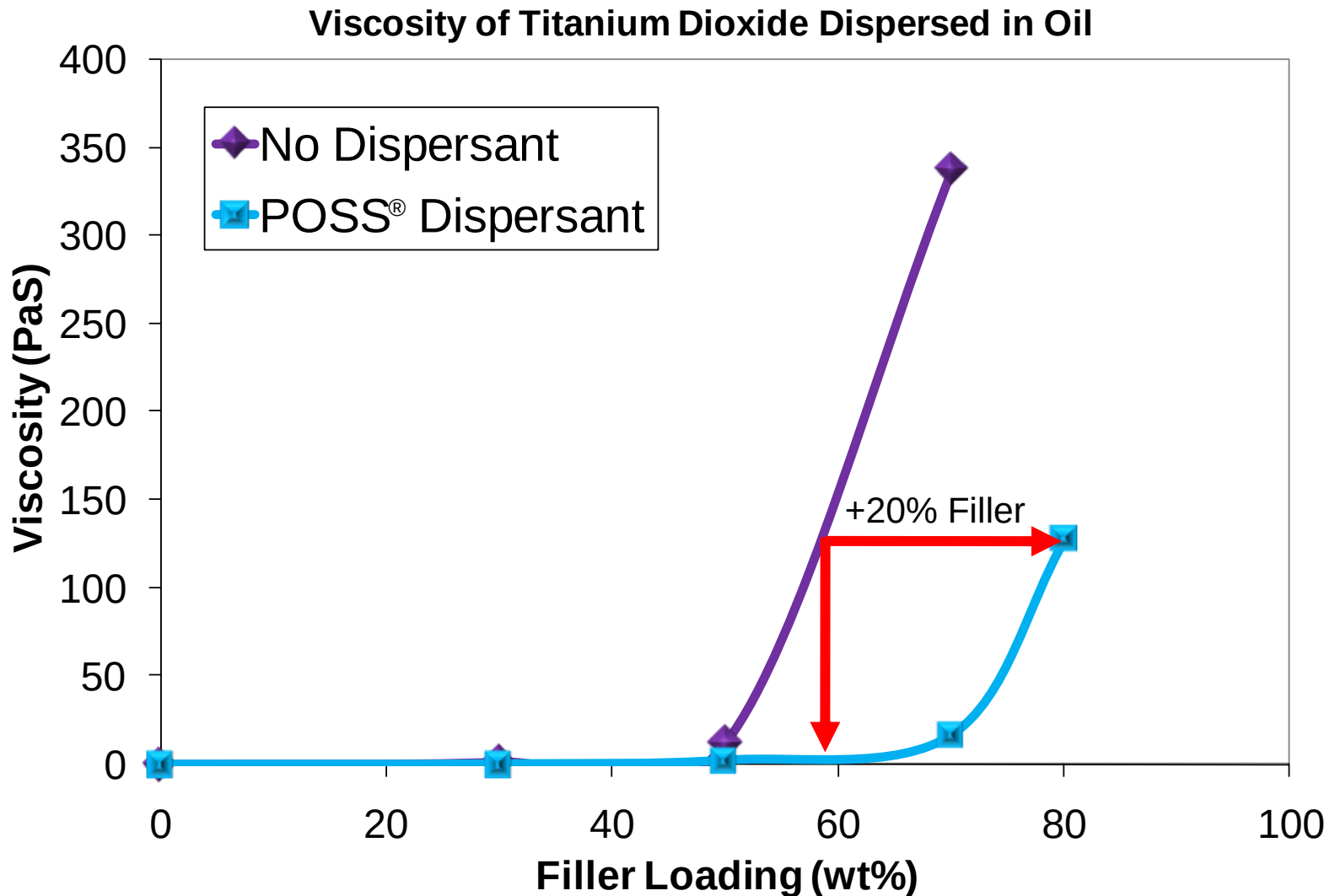


POSS® Dispersant Stability



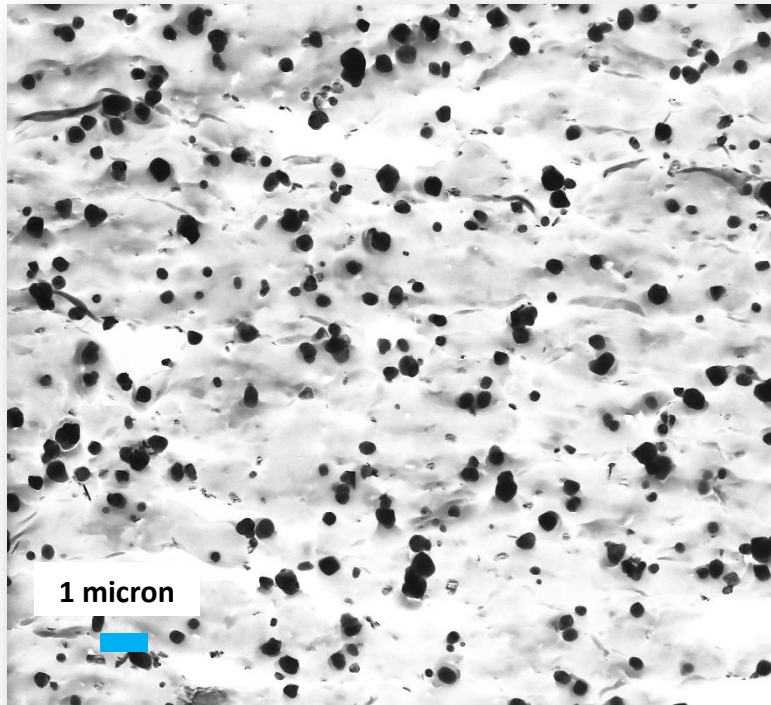
20°C / min under Nitrogen

POSS[®] Dispersant allows Higher Loadings

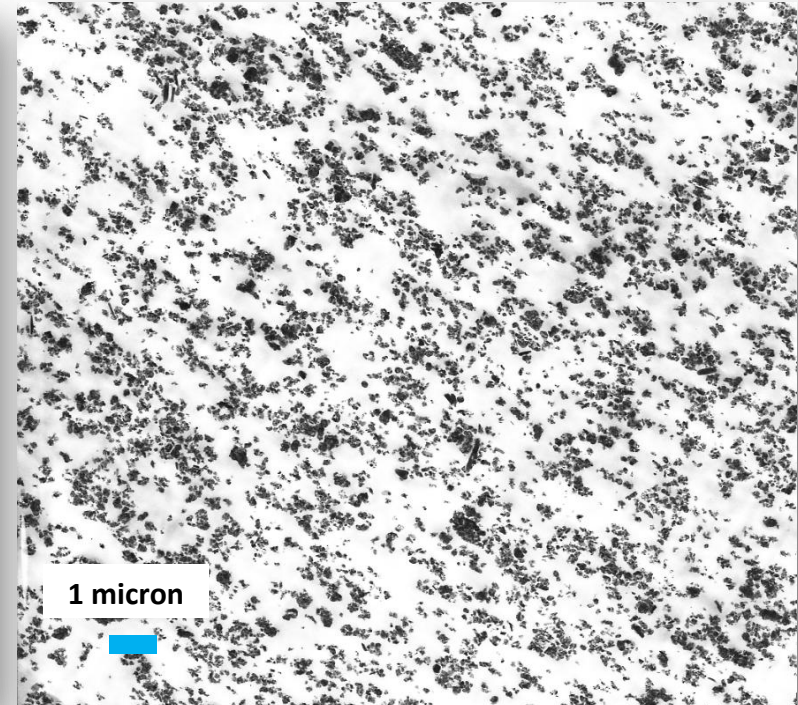


Viscosity @ 10sec⁻¹

TiO₂ with POSS[®] Dispersant in PEEK



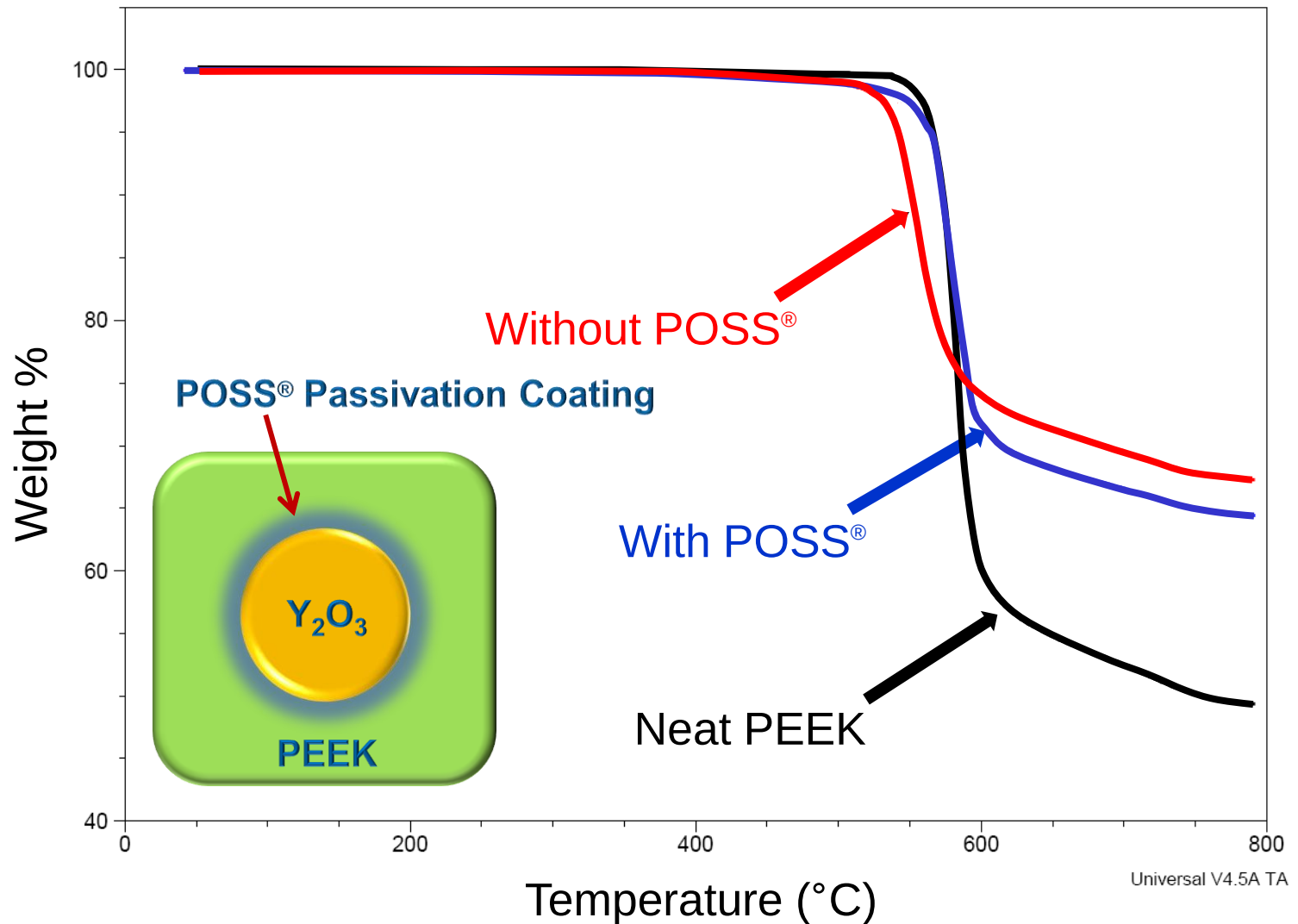
TiO₂ in PEEK
No Dispersant



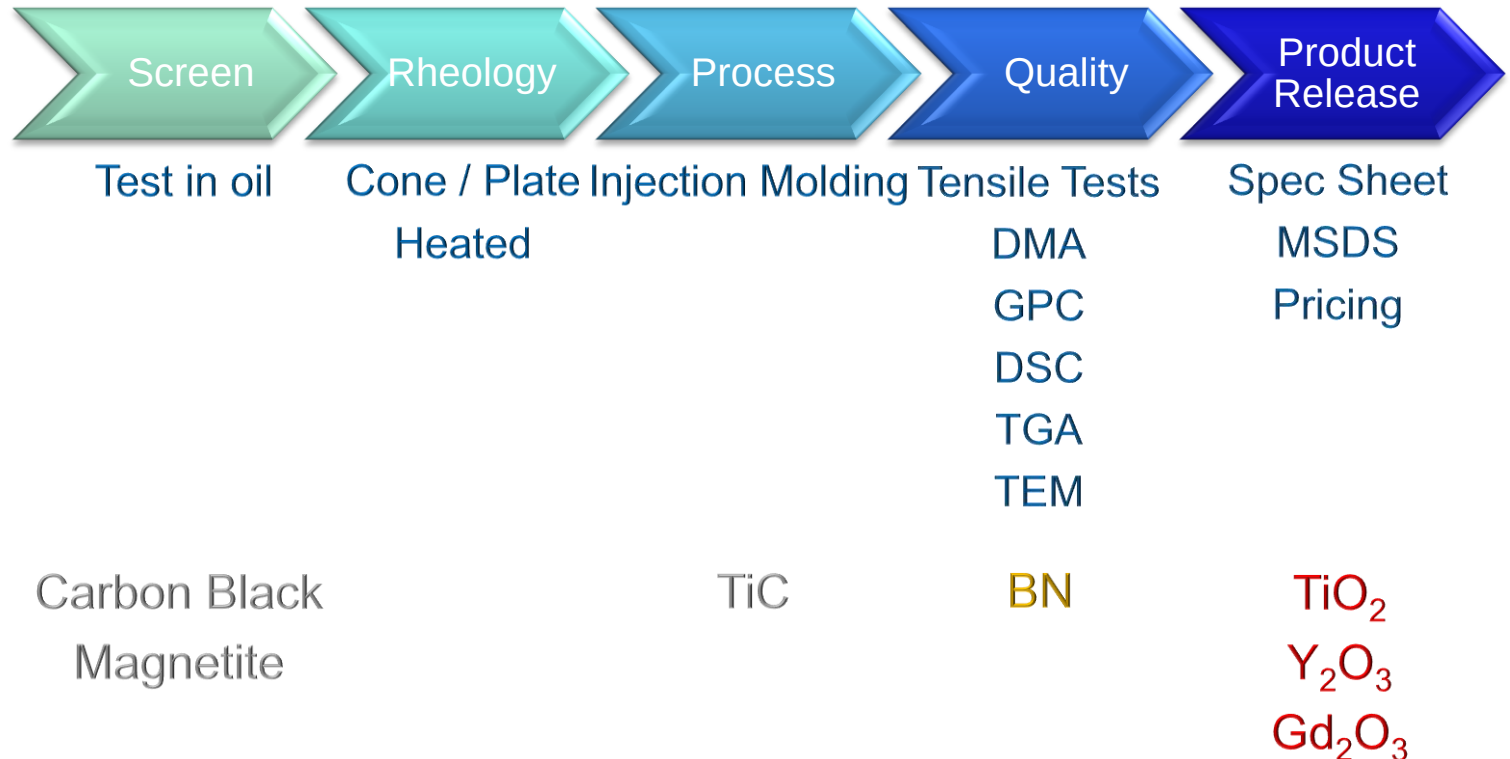
TiO₂ in PEEK
POSS[®] Dispersant

Greater whiteness & better mechanicals

POSS[®] Passivated Y₂O₃ in PEEK



POSS[®] Dispersants Development Scheme



Why use POSS[®] Dispersants?

- Drop in solution
- Enhanced flow / processability
- Improve aesthetics (e.g. gloss & color)
- Better mechanical properties (impact resistance & elongation to break)
- Thermally stable >400°C
- Wide range of fillers:
 - titanium carbide, boron nitride, yttria, silica, titanium dioxide, calcium carbonate, mica, clay, wollastonite, iron oxides, titanium diboride, bismuth subcarbonate, metal particles, carbon black etc...

POSS[®] Production & Safety

Safety of POSS[®]

Several of the larger production volume POSS[®] types are TSCA listed

Octaisobutyl POSS[®] MS0825

US Category IV Oral LD50 > 5000 mg/kg

Octamethyl POSS[®] MS0830

EU Testing Oral LD50 > 2000 mg/kg

Dodecaphenyl POSS[®] MS0802

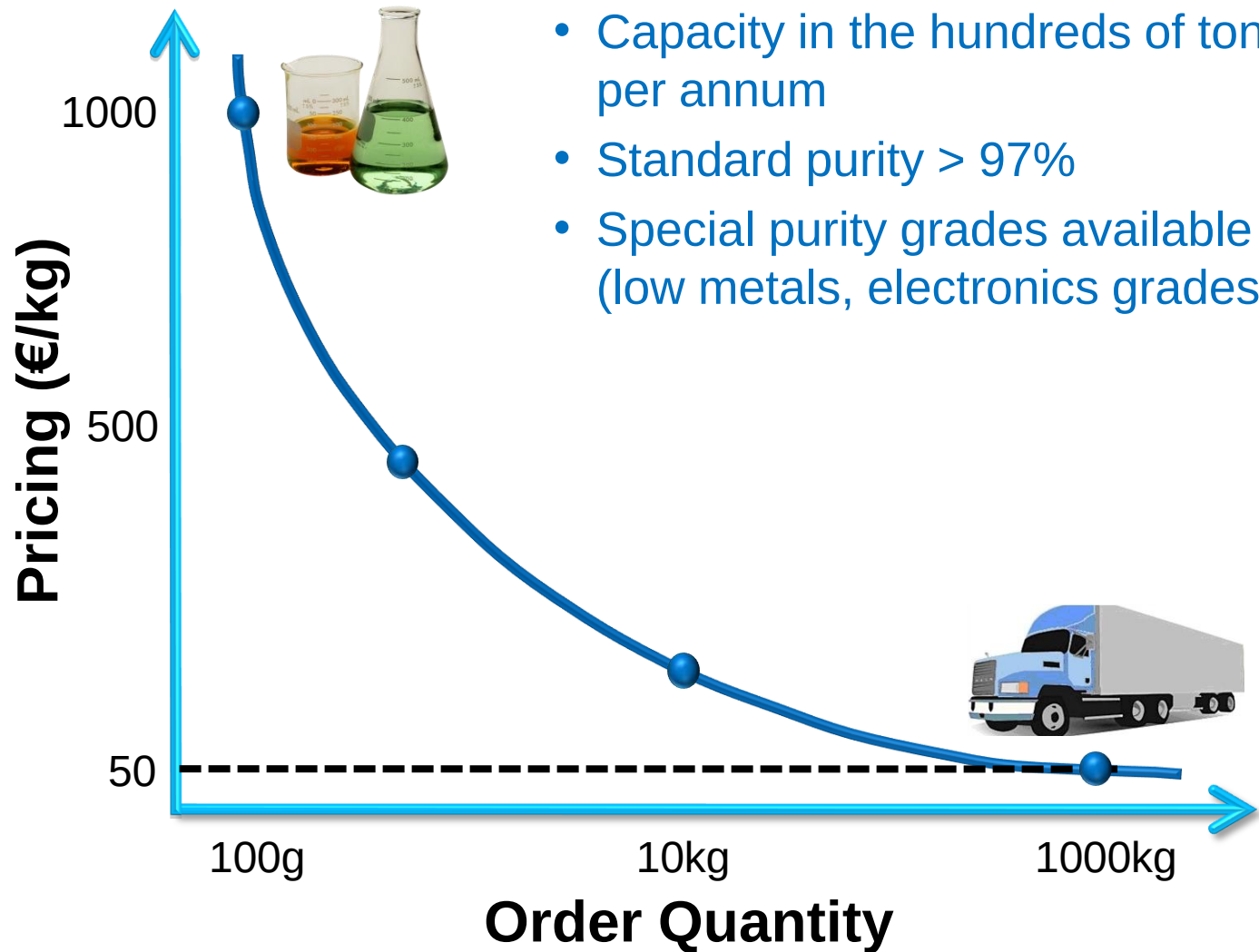
EU Testing Oral LD50 > 2000 mg/kg

Does **not** require the risk phrase R22 “Harmful if Swallowed”

Fish testing showed no toxicity

FDA food contact approvals underway

POSS[®] Pricing



Hybrid Plastics Inc.

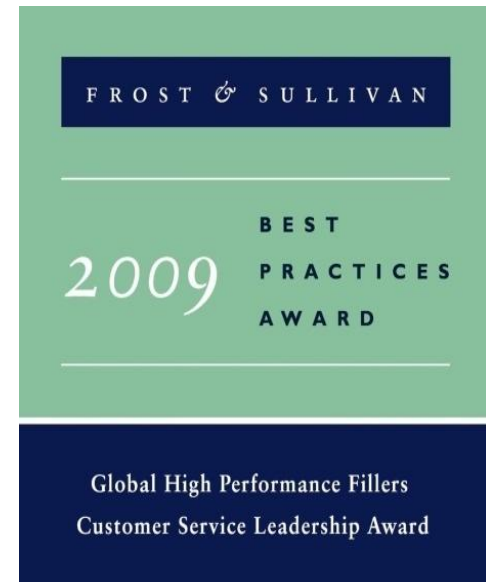
- Founded in 1998
- Spin-off from the Air Force Research Lab at Edwards
- Privately held
- Over 20 years experience in POSS[®]
- Controls POSS[®] IP
- Experienced management team and materials / polymer scientists
- Supported by excellent labs and production facilities

Hybrid Plastics Inc.



Summary

- POSS[®] additives available neat or in masterbatch concentrate
- New POSS[®] applications and products arriving all the time
- Hybrid Plastics works closely with customers to develop new products
- Call now!





Thank you!