Polyketone – Cost Efficient Option
In this Tight Supply Environment

Cliff Watkins & Jeremy Bland
PolySource LLC
Polyketone – Cost Efficient Option In this Tight Supply Environment

Cliff Watkins PhD
Director, Applications Development
(302) 528-2036 / cliff@polysource.net

- 39-year plastics industry veteran
- Past owner of TP Composites - bought by Techmer PM in 2013
- PhD Chemistry
- 14 years with PPG Glass

Jeremy Bland
Materials Technology Manager
(515) 782-2056 / jeremy@polysource.net

- 22-year plastics industry veteran
- Pittsburg State University - Plastics
- Process Engineering Expertise
- Six Sigma Black Belt
Protecting Your Business and Your Customer’s Business

- Insufficient Cargo Ship Capacity
- Force Majeure
- Allocation
- Extended Lead Times
- Weather
- Lethargic US Port Delays
- Booming Asia Demand
- Short Staffed
- Price Increases

What’s Your Issue Today?
From our 2018 MAPP Presentation on the PA6/6 Shortage

- Chronic shortages of ULTEM, the past 10 yrs
- Evonik plant explosion, PA12 global mess
- SABIC SAP conversion, ‘the mother of all mess’s
- Nine (9) Force majeures in 8 months in Nylon 66, global shortage

“He who forgets history, is doomed to repeat it”

George Santayana
In just 3 years, we’re scrambling again

To 2021....

➢ Force Majeure declarations from Ascend, Celanese, Covestro, DuPont...

➢ The “world” is sold out on everything

Except aliphatic polyketone or POK
The 2021 Supply Outlook

US Domestic resin production

- Polyolefins
- Polycarbonate
- Polyamides
- Polyacetal
- Styrenics

- Weather Issues
- COVID Shutdowns
- Short Staffed
- Demand exceeding supply

Lead Times Remaining Very Long through the Summer (>12 Weeks)
Sales Control, Allocation and Suppliers not accepting New Customers
The 2021 Supply Outlook

Asia Imports

- Polyolefins
- Polycarbonate
- Polyamides
- Polyacetal
- Styrenics
- Polyesters

- Booming Demand in Asia
- Insufficient Cargo Ship Capacity
- 16 Week LT
- Lengthy US Port Delays
The 2021 Supply Outlook

- The global pandemic has completely [insert expletive] the plastics industry

- The power grid failure in TX was like kicking someone [insert unpleasant visual]
1. What resin or compound are using now?

2. Use the Design Funnel to uncover the key requirements or “critical to quality” [CTQ’s]

3. Will your customer invest time and money to approve a material change

Polyketone is readily available is a strong option for many applications
The PolySource Design Funnel

Physical
- Dimensional Stability
- Flatness & Warp
- Color & Appearance

Chemical
- Exposed to Chemicals
- Environmental Humidity
- Immersion / Splash Contact

Thermal
- Use Temperature
- Min / Max Boundaries
- Spike Temperature

Mechanical
- Impact
- Strength
- Stiffness
- Static & Dynamic Load
- Sliding or Rotating
- Snap-fit, Screw Boss, Threads
- Electrical Properties
- Flammability
- Weatherability

Regulatory
- UL, ATEX, FDA, USP Class VI, ISO 10993, EU 10/2011
- Automotive Approval

Material Options
1_________
2_________
3_________

Lots of Upfront Questions, to Generate Answers...

That lead to the best material options
**How to think about POK as a supply option?**

<table>
<thead>
<tr>
<th>POK is a semi-crystalline resin</th>
<th>POK has</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unfilled - high mold shrinkage like POM</td>
<td>• Excellent chemical resistance</td>
</tr>
<tr>
<td>• Reinforced POK – Shrinks like Zytel 70G or Valox 420</td>
<td>• Excellent low coeff. of friction</td>
</tr>
<tr>
<td>• Comparable thermal resistance to PA612</td>
<td>• Very good mechanical prop’s</td>
</tr>
<tr>
<td></td>
<td>• FDA, NSF and USP Class VI</td>
</tr>
<tr>
<td></td>
<td>• Supply is plentiful</td>
</tr>
</tbody>
</table>

**POK has already replaced these ‘classic’ resins in many applications**
Processing POK in Existing Equipment

- **Screws n Barrel**, GP screws work great, typical metal alloys
- **Cold Runner & Hot Manifolds**, 20% Regrind, Hot drops, Valve gating
- **Barrel & Melt Temps**, Broad range, good residence time window
- **Drying** 2-3 hours, not hygroscopic
- **Molds and Shrinkage** fast cycling, releases well, predictable shrinkage

You don’t need to change your molds!
The Short Path, for today’s discussion

It's all about Thermals, Mechanicals and Mold Shrinkage
“Bang for the Buck”

Continuous Use Temp. is very different than HDT
“Bang for the Buck”

Continuous Use Temp. is very different than HDT
Some High Impact Options too!

We have developed some brand-new high impact POK grades to help even with “super tough” supply issues.
### The INTEGRA POK Toolbox

<table>
<thead>
<tr>
<th>Impact Strength &amp; Stiffness</th>
<th>Lubricated</th>
<th>Specialties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Fiber</td>
<td>PTFE</td>
<td>X-Ray &amp;/or Metal Detection</td>
</tr>
<tr>
<td>Carbon Fiber</td>
<td>Silicone</td>
<td>Medical</td>
</tr>
<tr>
<td>Minerals &amp; Glass Beads</td>
<td>p-Aramid</td>
<td>Thermal &amp;/or Electrical Conductivity</td>
</tr>
<tr>
<td>High Impact</td>
<td>MoS(_2) (moly)</td>
<td>Anti-Counterfeiting</td>
</tr>
<tr>
<td>FR</td>
<td>Graphite</td>
<td>Laser Marking</td>
</tr>
</tbody>
</table>

**INTEGRA POK Resins and Compounds for Molding and Extrusion**
Successful POK Replacements VS “classic resins”

- **PA6**, Seed Firmer, Ag Market
- **PA6 IM**, Conveyor Bucket, Material Handling Market
- **POM IM**, Conveyor Sorting Shoe, Material Handling Market
- **PA66**, wear bushing, RV Market
- **PA612 IM**, Spiral chain link, Material Handling Market
- **POM**, seed singulator, Ag Market

All 6 examples were successful in Existing Tooling with POK Grades We Stock
Package Handling Sorter

Issue:
Lead time on DELRIN 100P extended to “we don’t know when we can ship your order”

CTQ’s
- Similar mold shrink to 100P
- Low friction
- Resistant to greases and lube oils

Time to approve
- 1 week for mold trial
- 1 week to measure fit and dimensions
- 4 weeks beta site field test

INTEGRA™ POK 9070
1st Order Shipped in 6 Weeks, 10% Savings to the Customer, Savings in their End Market, PRICELESS

PolySource
Resin • Solutions • Delivered
Commercial Planter, Seed Firmer

Issue:
High viscosity PA6 absorbs moisture causing loss in part modulus-failures-customer complaints.

CTQ’s
• Similar mold shrink to Ultramid B4
• High ultimate strain (excellent toughness)
• Abrasion resistant to sandy soil
• 2-year UV resistance

Time to approve
• 1 week for mold trial
• 1 week to measure fit and dimensions
• 2-month beta site field test

INTEGRA™ POK 9070, Black w UV
Customer Complaints Reduced to Near Zero!
Issue:
High impact PA6, very high price and lengthy lead time

CTQ’s
• Similar mold shrink to current material
• Excellent drop impact toughness
• Abrasion resistant and low COF
• Food contact compliant

Time to approve
• 1 week for mold trial
• 1 week to measure fit, dimensions and drop impact

INTEGRA™ POK 9060 FC1
Big Cost Savings to the Customer, Enhanced Abrasion Resistance & Gained 2 New End Markets with Food Contact
Issue:
High impact PA612 very long lead time and high price

CTQ’s
- Similar mold shrink to current resin
- High ultimate strain (excellent toughness)
- Abrasion resistant and low COF dry sliding
- Adhesion with over-molded TPR 2nd Shot

Time to approve
- 1 week for mold trial
- 1 week to measure fit and dimensions
- 1 week for 2 shot over-mold trial and peel strength
- 1 month beta site field test

INTEGRA™ POK 9060 FC1
Material consolidation, Big cost savings to the customer
Protecting Your Business and Your Customer’s Business

Insufficient Cargo Ship Capacity

Force Majeure

COVID Shutdowns

Allocation

Booming Asia Demand

Extended Lead Times

Short Staffed

Weather

Lengthy US Port Delays

Price Increases

What’s Your Issue(s)!

PolySource
Resin • Solutions • Delivered
Polyketone (POK) Resources Available On polysource.net
Thank You for Joining the Discussion Today!!

- 39-year plastics industry veteran
- Past owner of TP Composites-bought by Techmer PM in 2013
- PhD Chemistry
- 14 years with PPG Glass

Cliff Watkins PhD
Director, Applications Development
(302) 528-2036 / cliff@polysource.net

- 22-year plastics industry veteran
- Pittsburg State University-Plastics
- Process Engineering Expertise
- Six Sigma Black Belt

Jeremy Bland
Materials Technology Manager
(515) 782-2056 / jeremy@polysource.net