

Metal Injection Molding: Catamold®

A Proven Technology for Complex Steel Automotive Components

Presenter

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Date and Location:

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Engine Expo - Novi, MI

Webinar Agenda



- **Who is BASF and What is Catamold®?**
- The Basics of MIM
- Benefits of MIM
- Where is MIM a Fit?
- Properties of a MIM Component
- Proven Automotive MIM Applications
- Why BASF and Why Catamold®?

Company Overview

BASF – The Chemical Company



- **The world's largest chemical company**
- **Serving a wide variety of industries**
- **342 global production facilities**
- **2010 Sales: \$85 billion**
- **Employees: 106,000+**



Recognition

Acknowledgment in the Chemical & Automotive Markets



Voted Most Admired Chemical Company for the Last 5 Years



Ford World Excellence Award
2005 & 2007



GM Supplier of the year
2009 & 2010



Recognized as One of Top 20 Suppliers for
the Automotive Industry in 2010

What is Catamold® ?

BASF's standardized high-quality metal injection molding feedstock



- Comprised of metal powder and a specially engineered binder system.
- Utilizes conventional molding equipment to produce high quality steel components
- Serves a wide variety of markets from low to high volume production

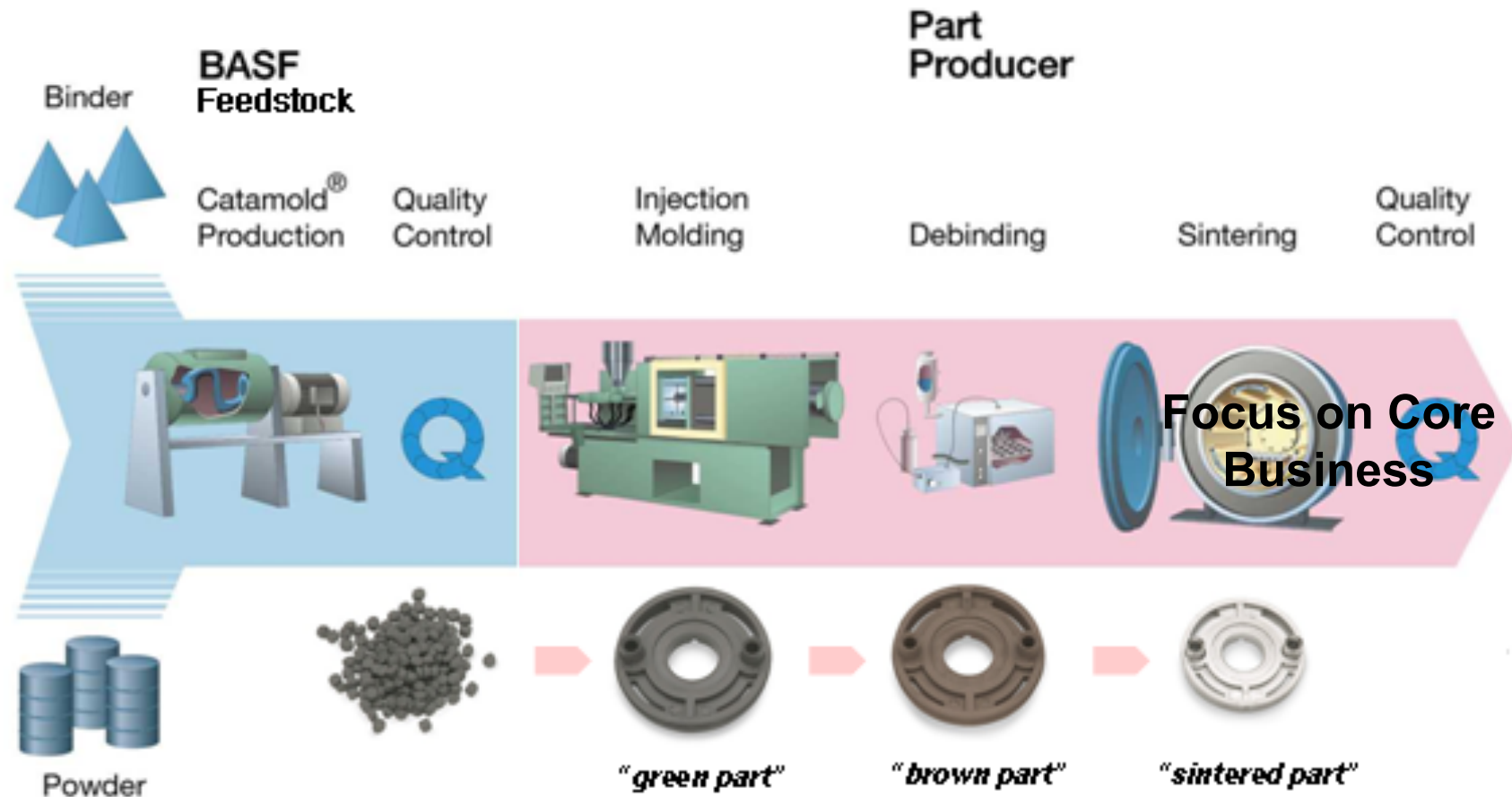
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Catamold® MIM

The Metal Injection Molding Manufacturing Process



Catamold® Product Offerings

Standardized Production Products



Low-alloyed Steels

- | | |
|----------|----------------|
| • FN02 | case hardening |
| • FN0205 | hardenable |
| • 4605 | hardenable |
| • FN08 | both |
| • 8620 | case hardening |
| • 8740 | hardenable |
| • 4140 | hardenable |
| • 4340 | hardenable |
| • 100Cr6 | hardenable |
| • 1010 | case hardening |

Specialities

- | | |
|----------------|-----------------------|
| • In100 (dev.) | heat resistant |
| • In713 (dev.) | heat resistant |
| • GHS-4 | heat, wear resistant |
| • Ti | non-magnetic, inert |
| • W | non-magnetic |
| • F15 | low thermal expansion |
| • M2 | wear resistant |

Stainless Steels

- | | |
|-----------|-----------------------|
| • 316L | non-magnetic |
| • PANACEA | non-magnetic, Ni-free |
| • 17-4PH | hardenable |
| • 420 | hardenable |
| • 430 | ferromagnetic |
| • 440Nb | hardenable |
| • 310N | heat resistant |

Soft Magnetic

- FS
- FeSi3
- FN50

Ceramics

- | | |
|---------------|---------------------------|
| • AO - F | Aluminium oxide 99,7 |
| • TZP - A | Tetragonal Zirconia |
| • TZP - F 315 | Black Tetragonal Zirconia |

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Benefits of MIM

Taking Advantage of Polymer Mass Production Equipment & the Property Performance of Steel



- **Design Freedom & Weight Reduction**
- Cost Reduction
- Mechanical Performance
- Mass Production Capability
- Environmental Impact

Design Freedom

Hole and Slot Geometry

Mobile hinge



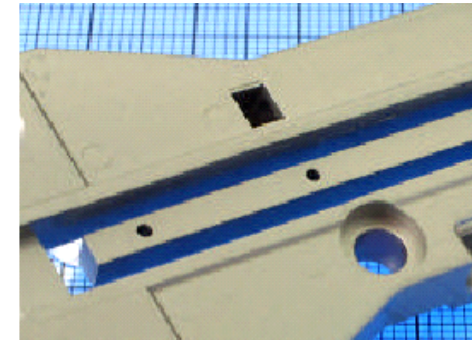
316LG - 2 gr.

Lock cylinder



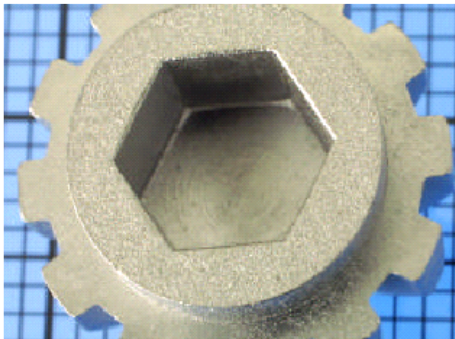
FN08 - 14 gr.

Nail gun



FN02 - 80 gr

Unscrewing head



420A - 8 gr.

Stator for fuel injector



FeSi3 - 18 gr.

- Cross Holes
- Angular Holes
- Functional Holes & Slots
- Square Holes
- Small Holes > 0.1mm

Design Freedom

Internal & External Threads

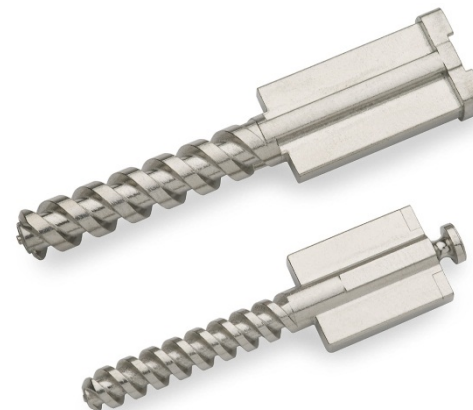
Dashboard Mounting Screw



17-4PH – 8 gr.

- Internal Thread

EGR Valve Adjustment Screw



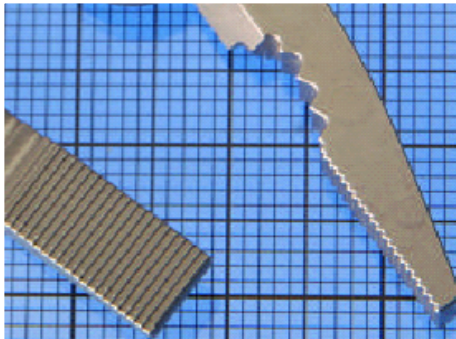
316LG - 10 gr.

- External Thread

Design Freedom

Textured or Defined Surface

Multitool

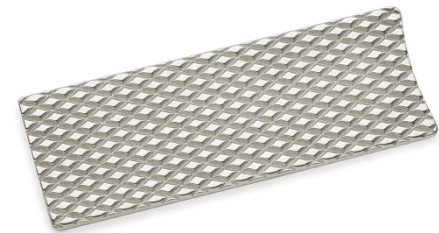


420A - 8 gr.

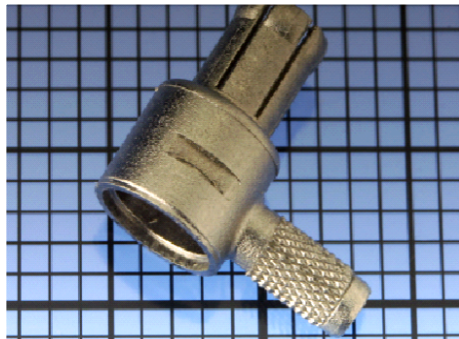
Dental Bracket



Miscellaneous Consumer



Antenna Plug for GPS System



17- 4PH - 0.4 gr.

- Serrations
- Knurling
- Texturing

Design Freedom

Text and Symbols

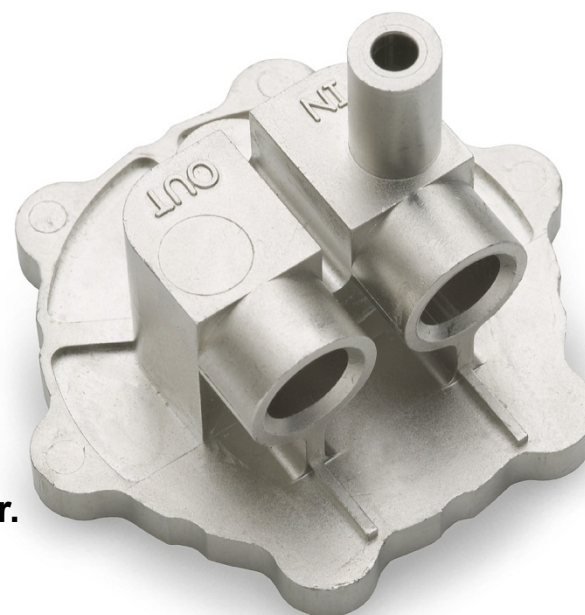
Burn Chamber for Auxiliary Heater



316LG - 30 gr.

- Production date
- Product identification

Pump Housing



316LA - 130 gr.

- Company logo
- Instructional Information

Design Freedom

Part Integration

Combine 7 piece design to a 2 piece MIM design

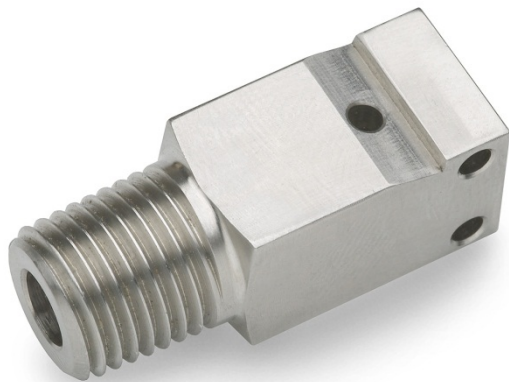
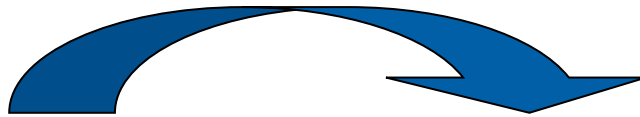
- Stamping
- PM
- Machining



Weight Reduction

Expensive Machining can be Eliminated with MIM

MIM



Weight reduction by 50%

Benefits of MIM

Taking Advantage of Polymer Mass Production Equipment & the Property Performance of Steel



- Design Freedom & Weight Reduction
- **Cost Reduction**
- Mechanical Performance
- Mass Production Capability
- Environmental Impact

Cost Reduction

Conversion from Machining to MIM

Connector for Automotive Hydraulic System



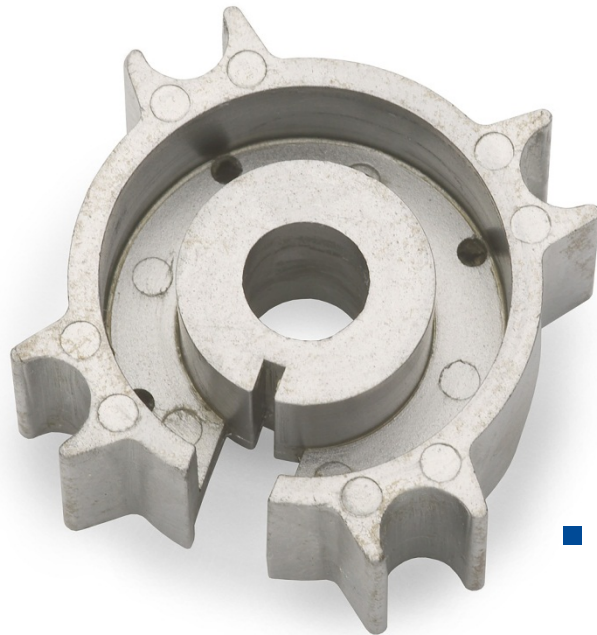
316LA - 2 gr.

- Originally two machined parts, brazed together
- Cost reduction 50 %
- Weight reduction 50 %

Cost Reduction

Conversion from PM to MIM

Stator for fuel injection system



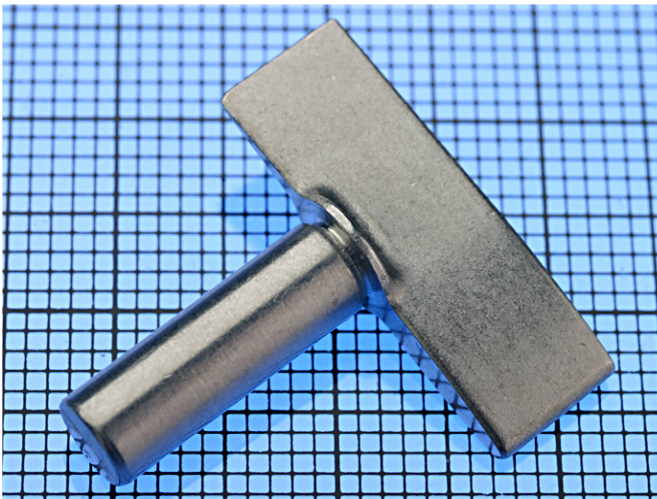
FeSi3 - 18 gr.

- Originally pressed, sintered and machined
- Smaller holes can be made in MIM
- Cost reduction 10 %

Cost Reduction

Conversion from Investment Casting to MIM

Vane for VTG turbocharger



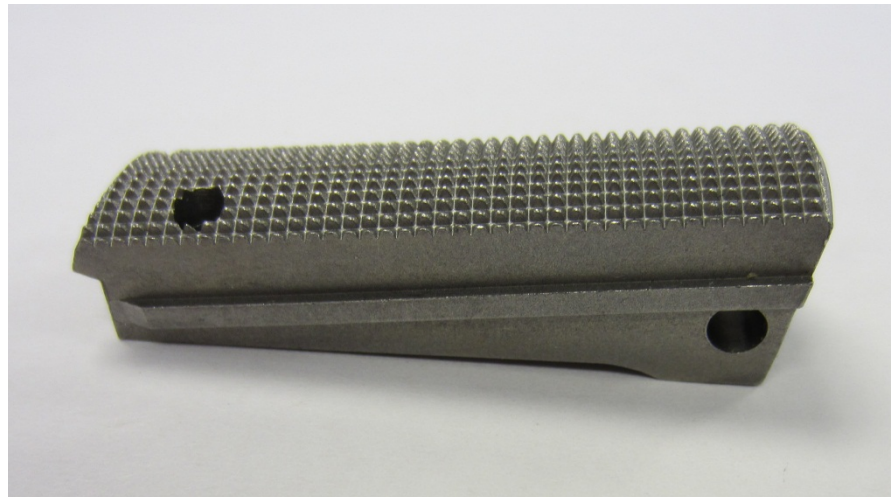
310N - 6 gr.

- Originally investment cast and machined
- Cost reduction 25 %

Cost Reduction

Molded In Texture of MIM Vs. Machining

Firearm Component



- Reduced Costs by 60%
- Increased the design freedom & functionality

Benefits of MIM

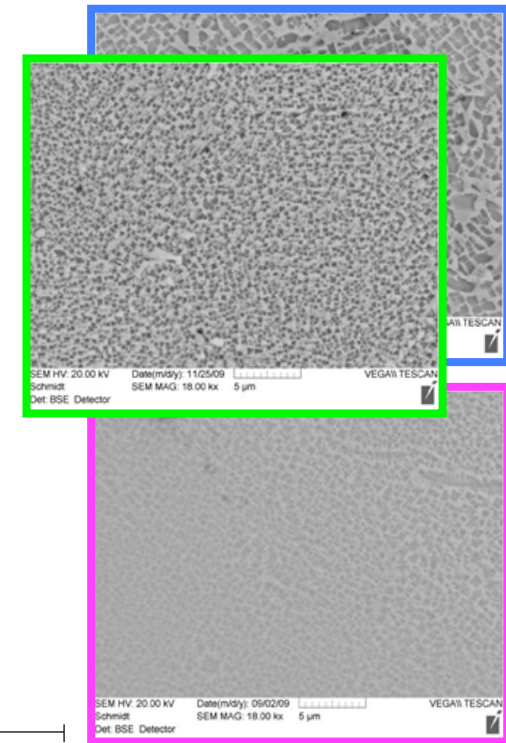
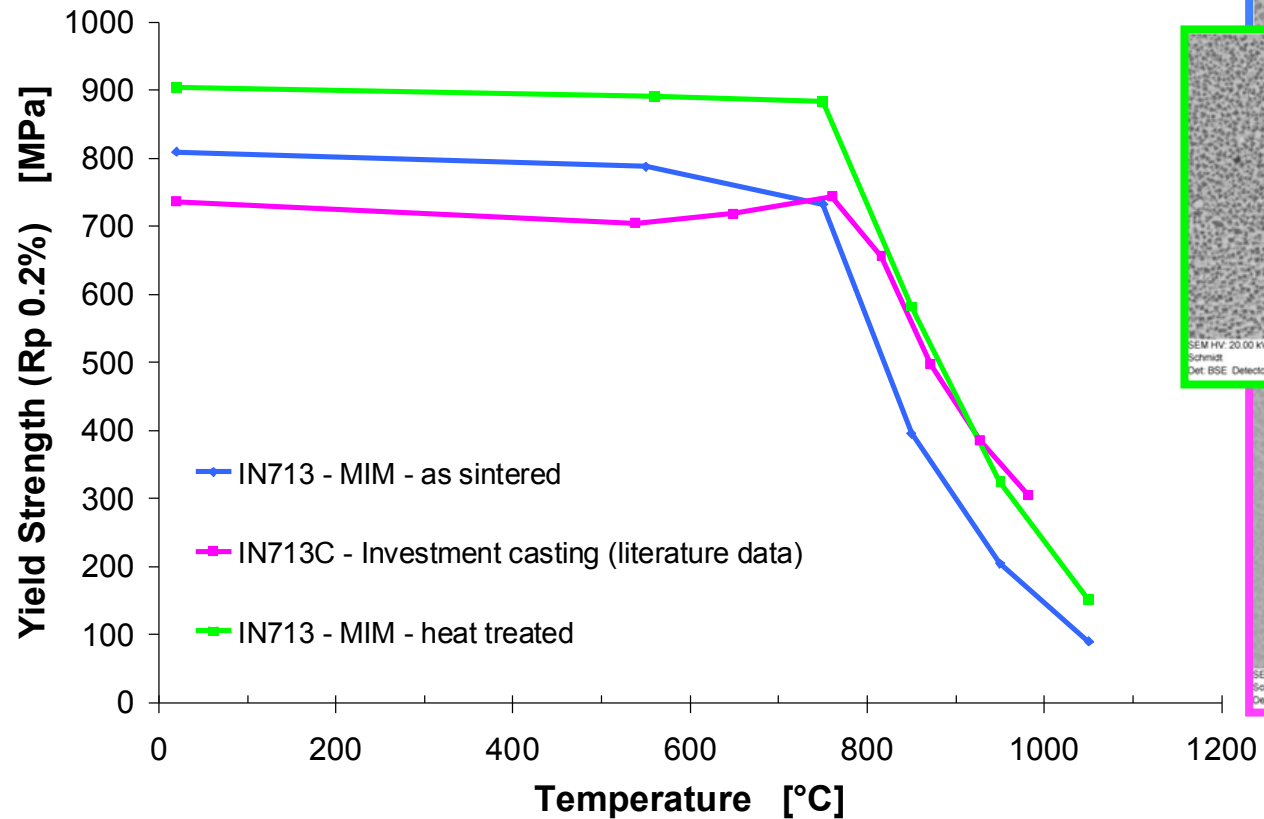
Taking Advantage of Polymer Mass Production Equipment & the Property Performance of Steel



- Design Freedom & Weight Reduction
- Cost Reduction
- **Mechanical Performance**
- Mass Production Capability
- Environmental Impact

Mechanical Performance

High temperature tensile test measurement



Benefits of MIM

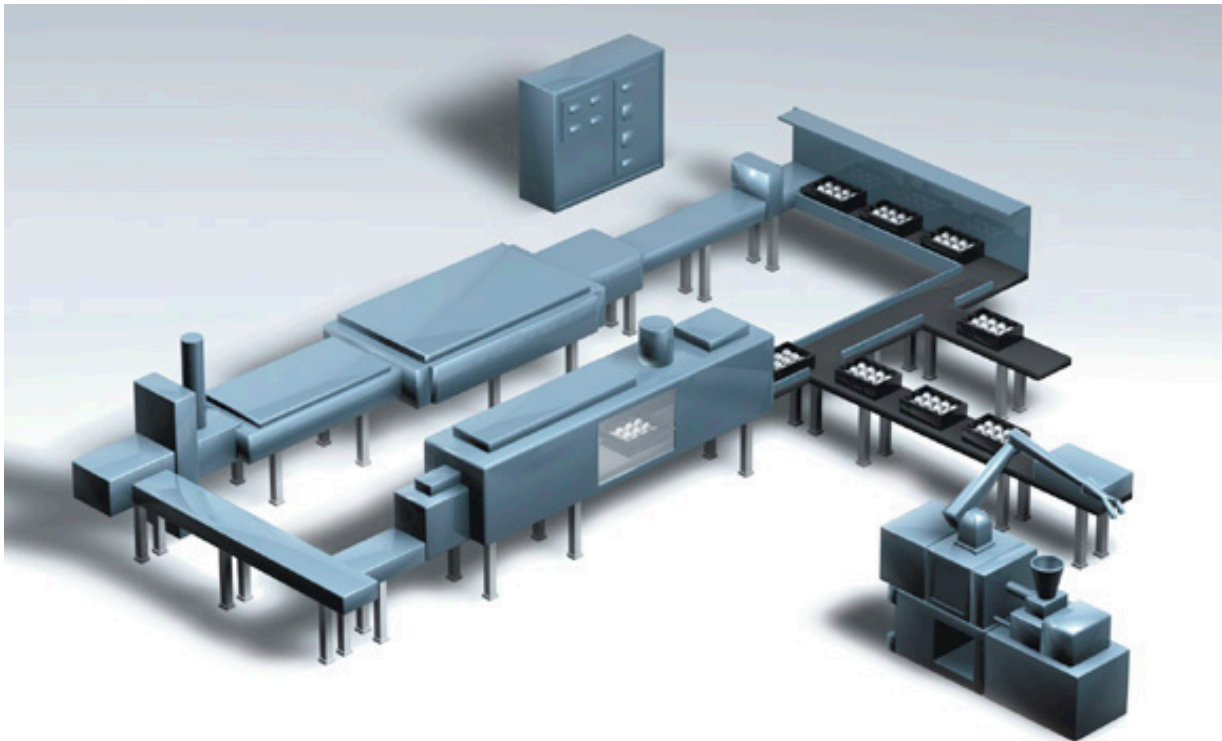
Taking Advantage of Polymer Mass Production Equipment & the Property Performance of Steel



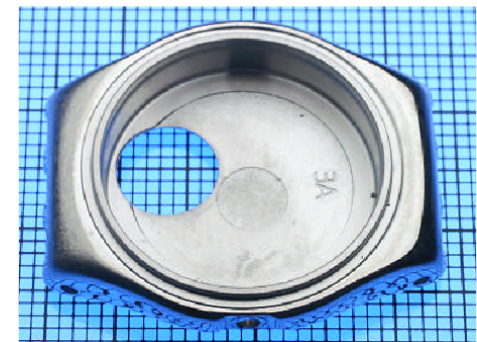
- Design Freedom & Weight Reduction
- Cost Reduction
- Mechanical Performance
- **Mass Production Capability**
- Environmental Impact

Mass Production Capability

Catamold is the Only True Fully Continuous Process



Watch case



316LG - 30 gr.

- MIM: Several millions of parts per year
- MIM plant operates 24 / 7
- No personnel during weekend

Benefits of MIM

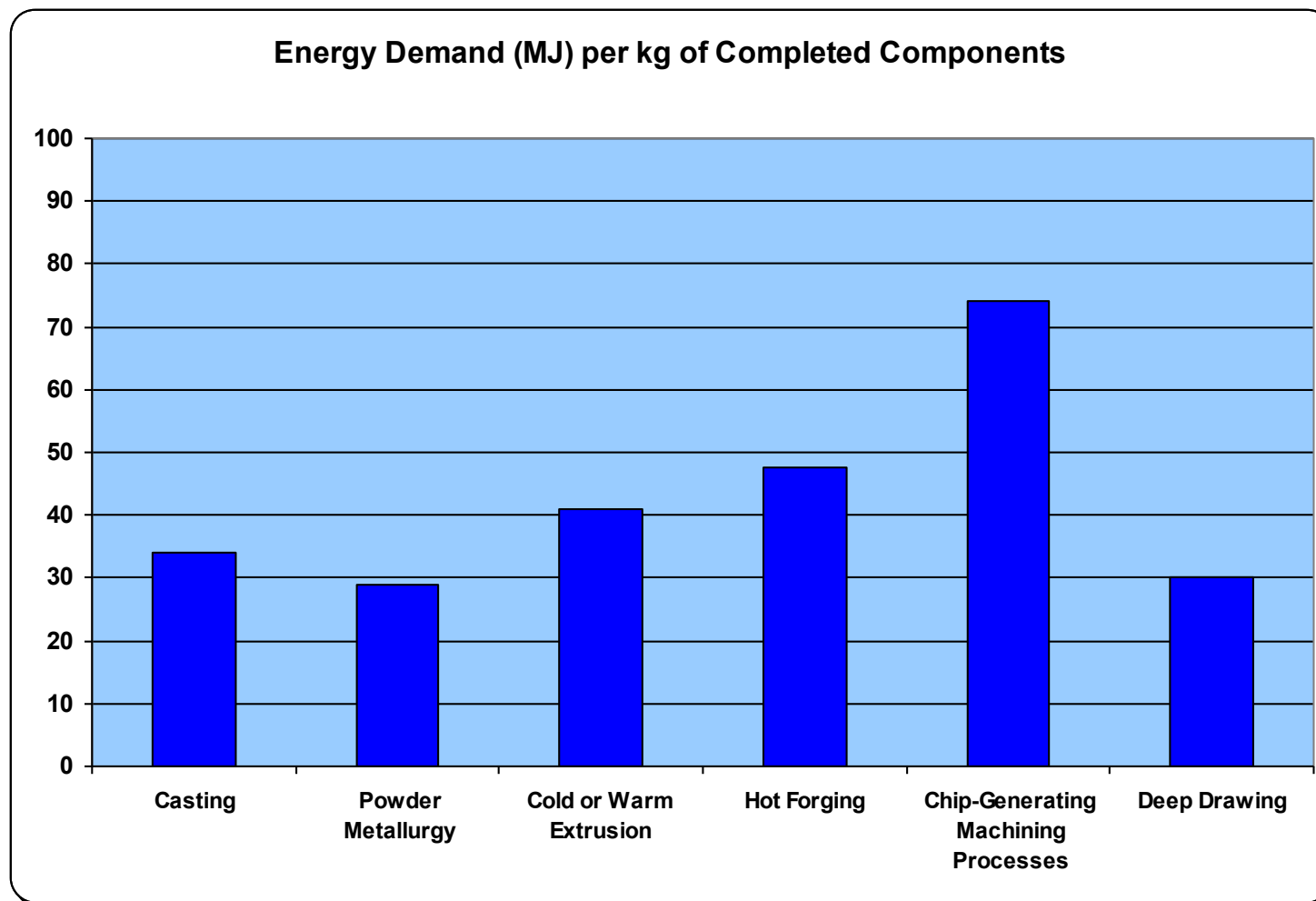
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- Design Freedom & Weight Reduction
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- **Environmental Impact**

Environmental Impact

Energy Consumption versus Fabrication Process



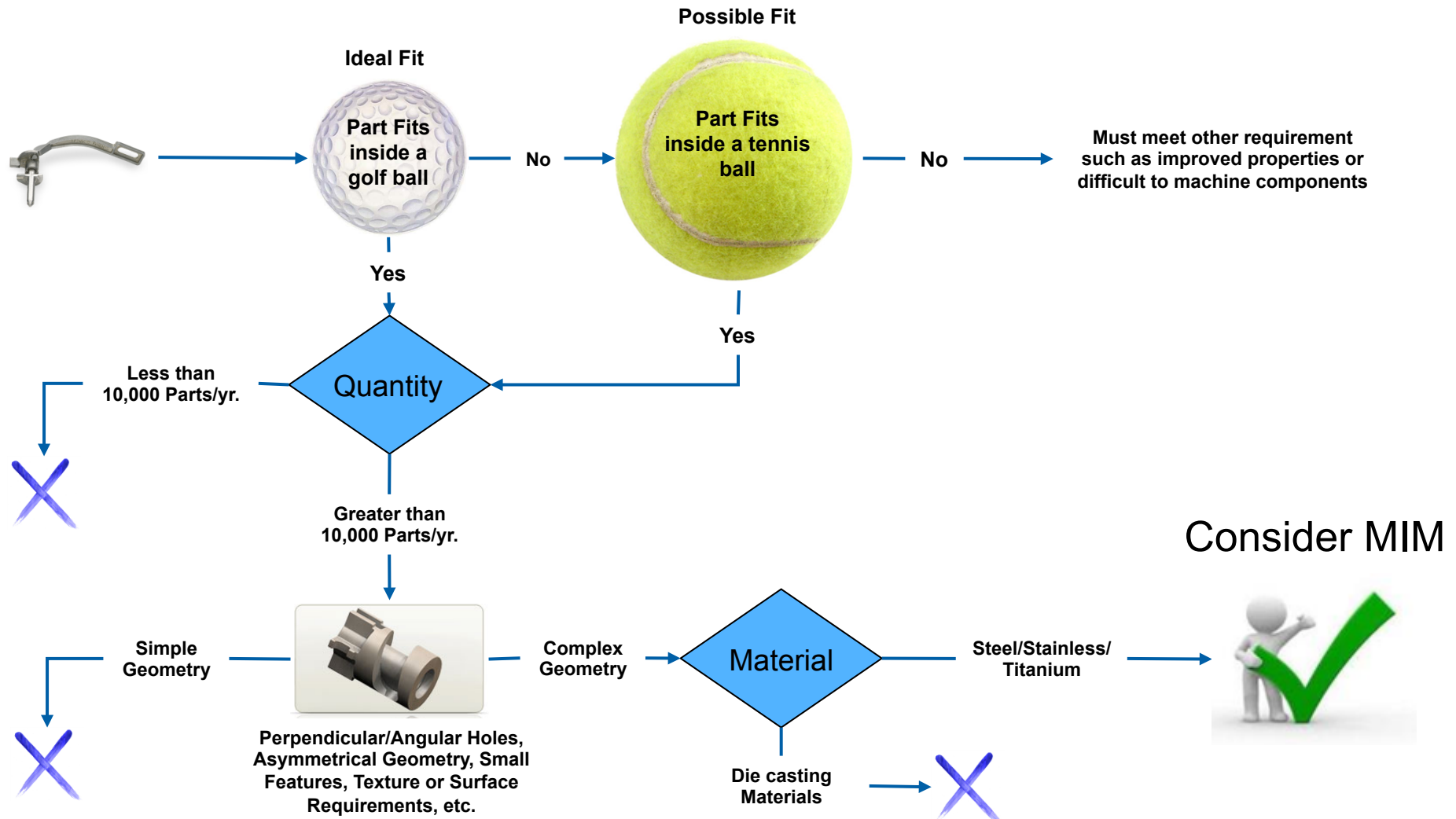
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- Proven Automotive MIM Applications
- Why BASF and Why Catamold®?

Where is MIM a Fit?

Decision Process for MIM Consideration



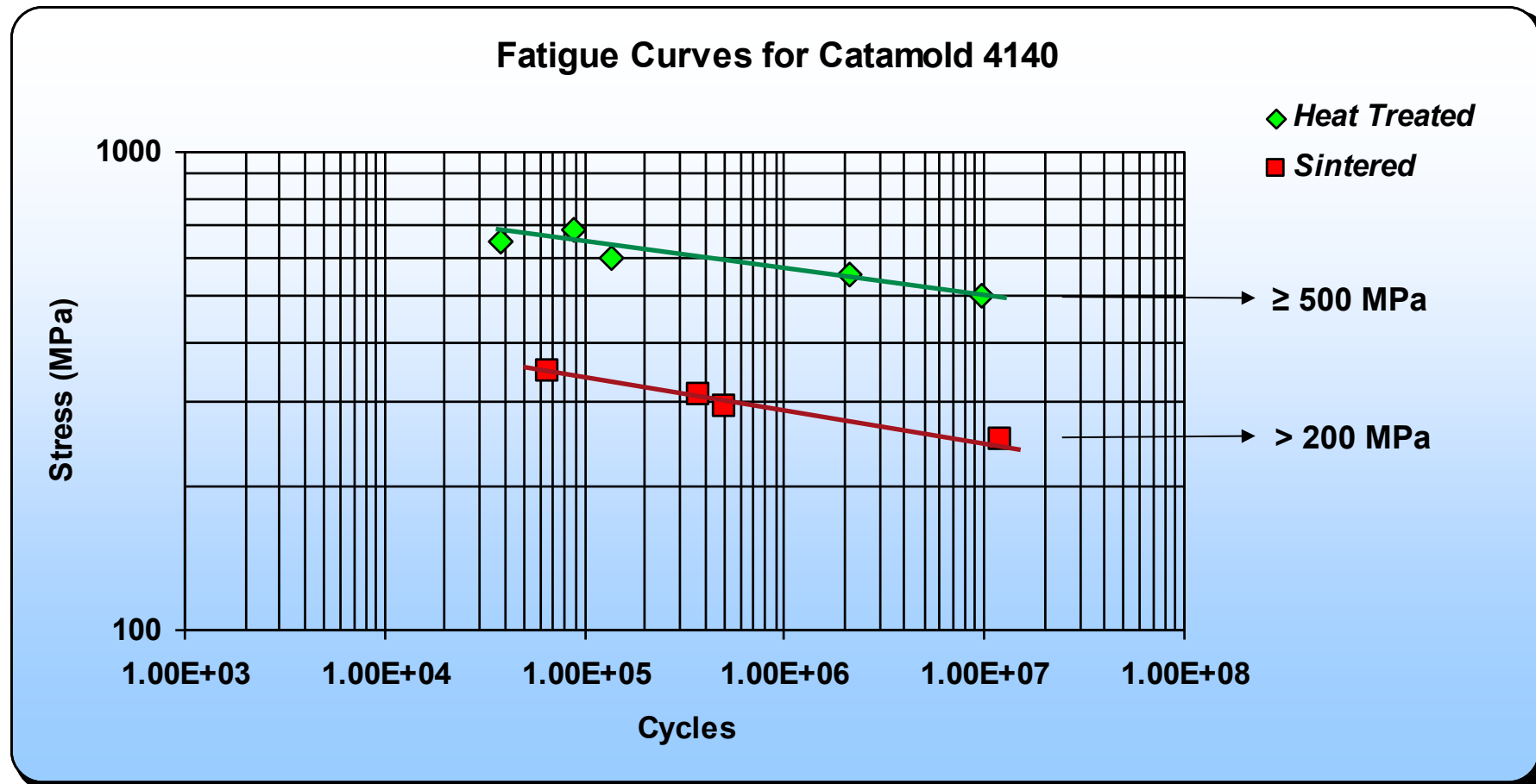
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- **Properties of a MIM Component**
- Proven Automotive MIM Applications
- Designing for MIM
- Why BASF and Why Catamold®?

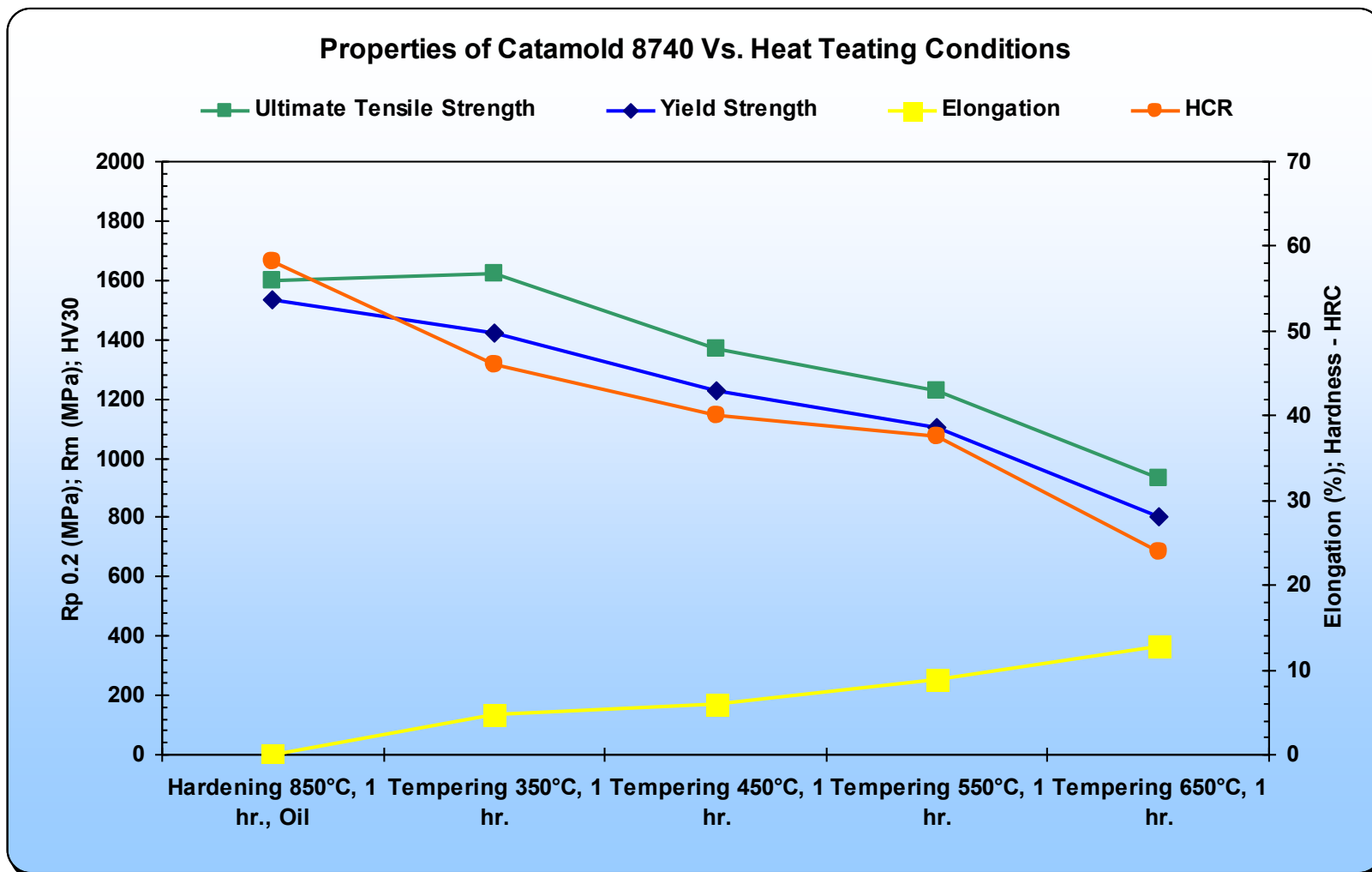
Properties of Catamold® 4140

Fatigue for As Sintered & Heat Treated



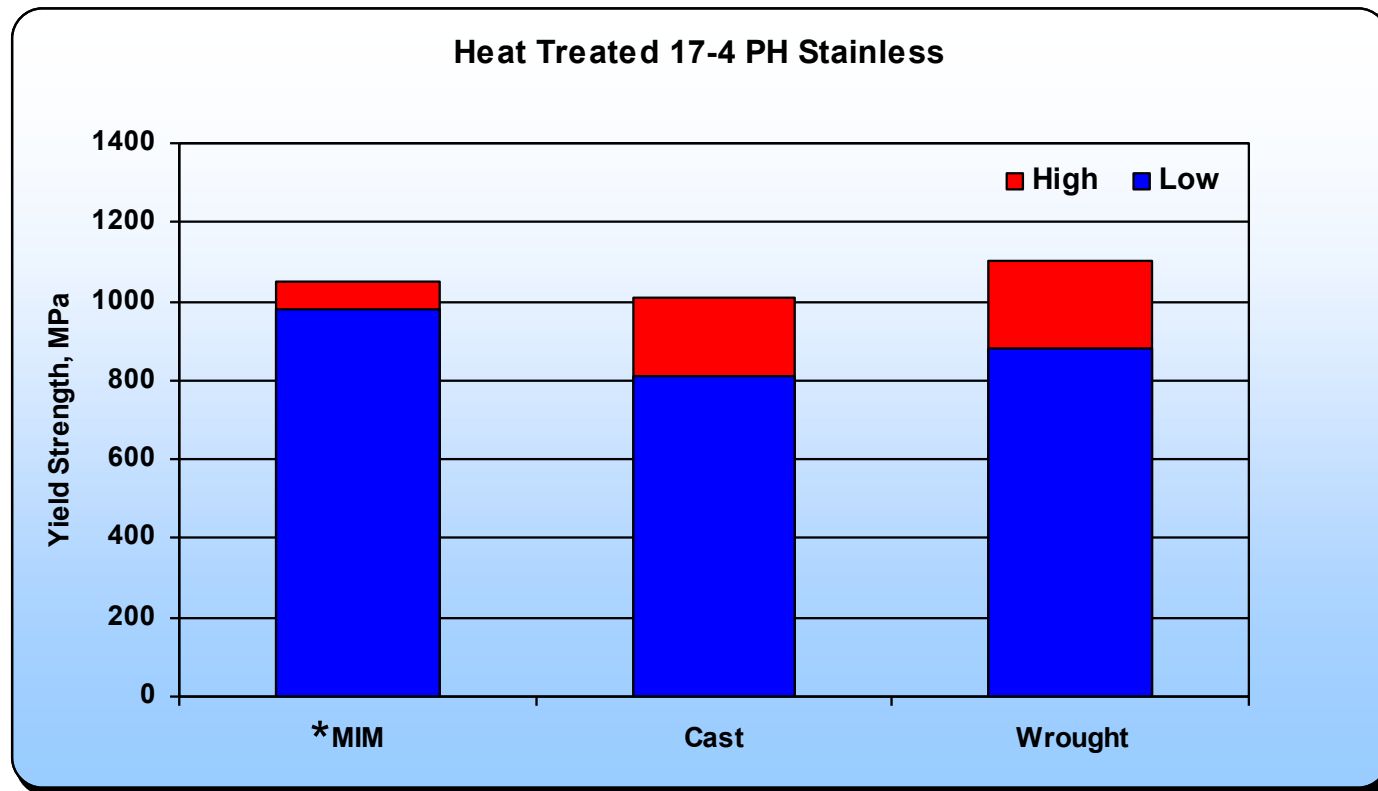
Properties of Catamold® 8740

Various Heat Treating Conditions



17-4 PH Stainless Steel

Yield Strength Comparison to Other Forming Processes



* Heat treated to the H1025 condition

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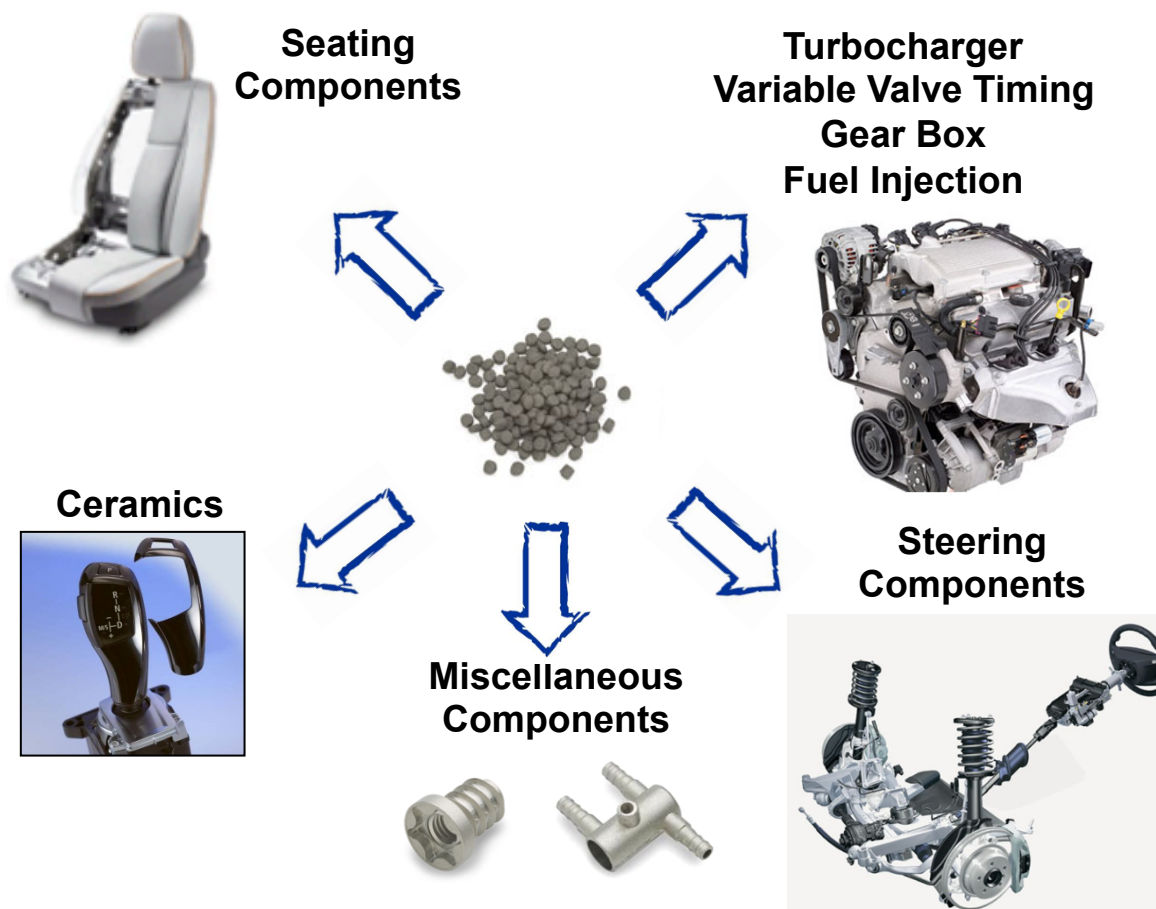


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Catamold Applications in Automotive

Proven Process Utilized in the Global Automotive Market

Metal Injection Molding

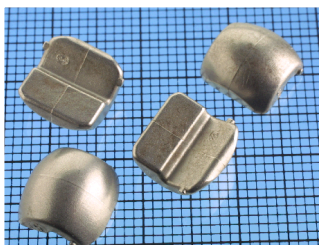


MIM Automotive Components

Ignition System Components



Ignition actuator
FN0205 - 1.5 gr.



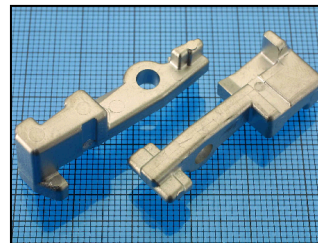
**Ignition system
Component**
316LA - 5 gr.



Ignition actuator
FN0205 - 0.8 gr.



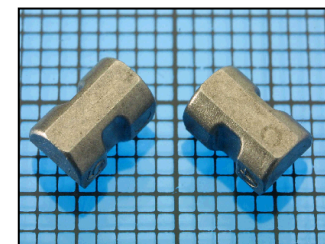
Ignition link guide
316LA - 8 gr.



Ignition lock
FN02 - 3 gr.



**Ignition system
Components**
FN02 - 1.5 gr.



MIM Automotive Components

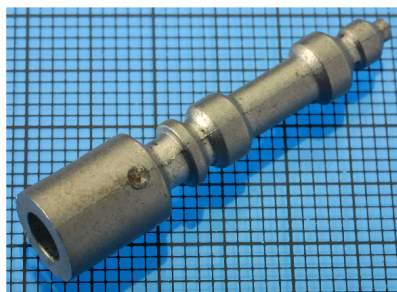
Fuel Injection Systems and Other Miscellaneous Parts

**Parts for seat
adjustment**

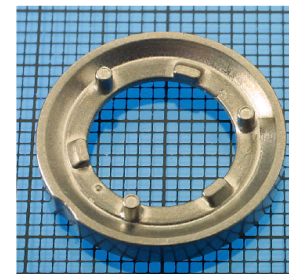
FN02 – 6 gr. / 13 gr. / 5 gr.



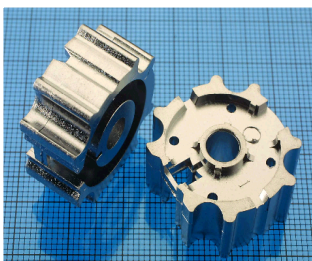
Nozzle for fuel injection system
440C - 3 gr.



**Ring for fuel
injection system**
316LA - 2 gr.



**Stator for fuel
injection system**
FeSi3 - 18 gr.



Piston cooling nozzle
316LA - 9 gr.



Parts for hand brake
FN02 – 10 gr. & 22 gr.

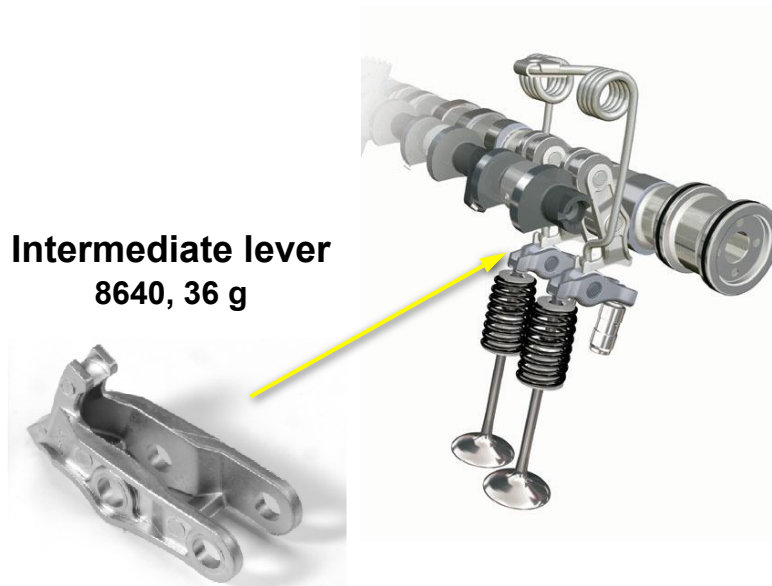


MIM Automotive Components

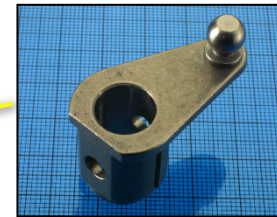
Variable Valve Timing

- Complex geometry, part size, and # of Components per VVT System
- High growth potential for US automotive market

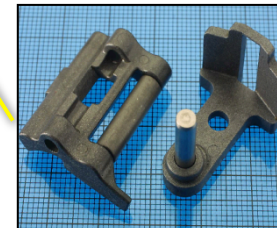
Intermediate lever
8640, 36 g



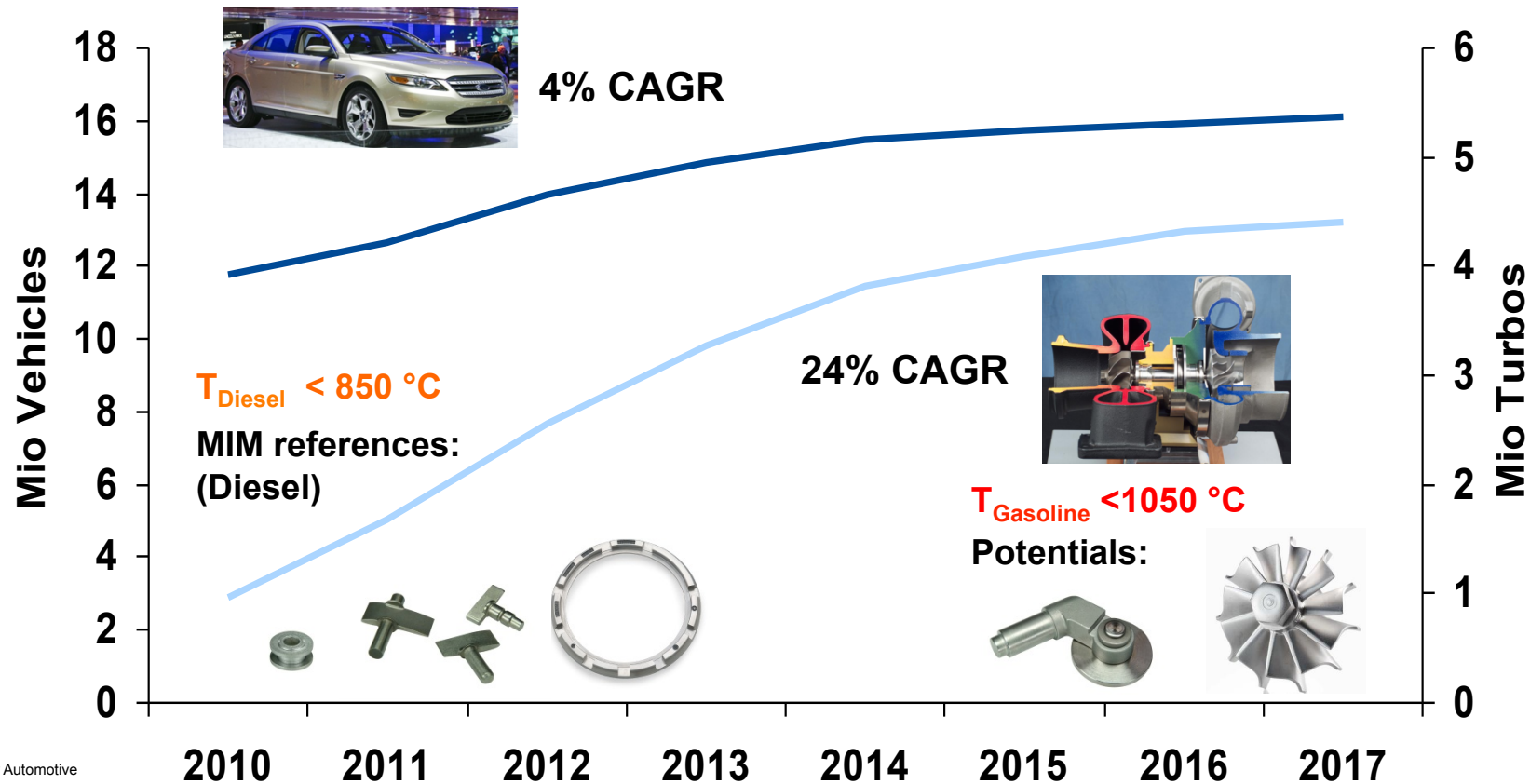
Lock for VVT
316L G, 15 g



Clips for VVT
FN02, 5 g



Turbocharger Growth in North America



Sources:
J.D. Power Automotive
Forecast

➔ Fuel efficiency requirements drive turbocharger utilization

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Why BASF and Why Catamold®?



- Recognized Industry Leader
- Only feedstock with global supply footprint
- BASF is a supplier to the greatest # of part producers
- Backward integration of key raw material supply
- Only feedstock enabling fully continuous processing
- World scale feedstock capacity
- Local technical support in every region
 - Dedicated technical lab
- High quality standard products available to all part producers

Thank You for Your Time *Questions?*



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