Metal Injection Molding of Wing/Flaperon

BAE Systems, NCDMM, U.S. Army and Polymer Technologies

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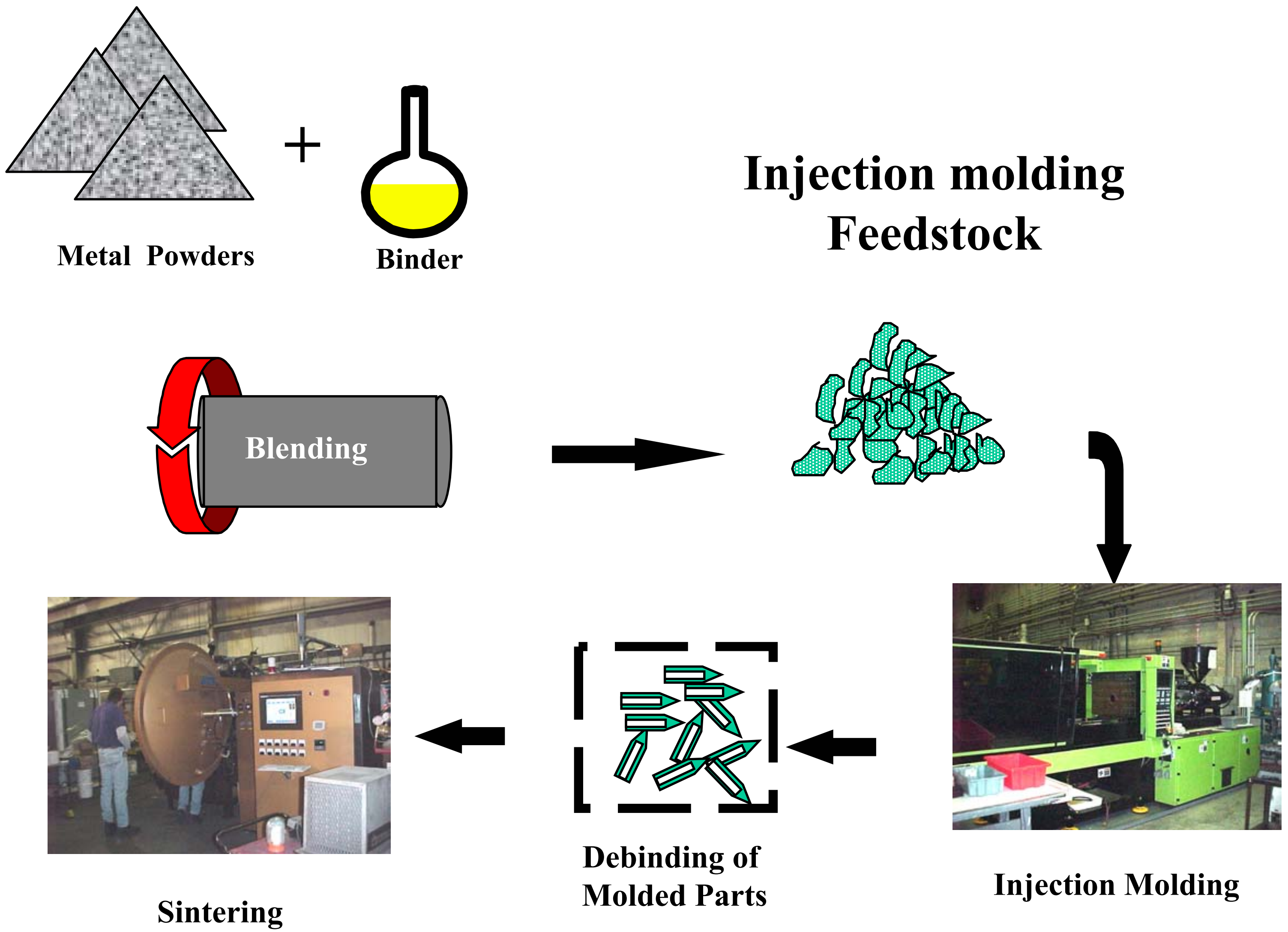
Latrobe, Pennsylvania
Mark F. Huston – Executive Director (724) 539-8132

Polymer Technologies Inc

- Started under the name of PTI in 1941. Was spun-off into Polymer Technologies Inc in 1987 to pursue value added, specialty work.
- Occupies 93,000 sq feet. Capable of expansion to 143,000 if needed
- Employees- 95

What is Metal Injection Molding?

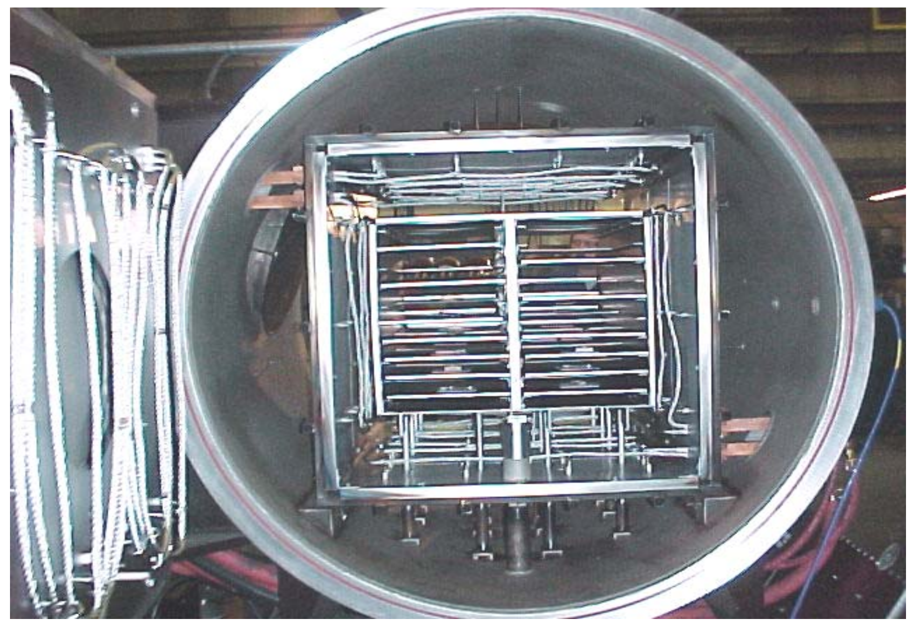


150 ton tie-bar-less Injection Molding Machine at PTI

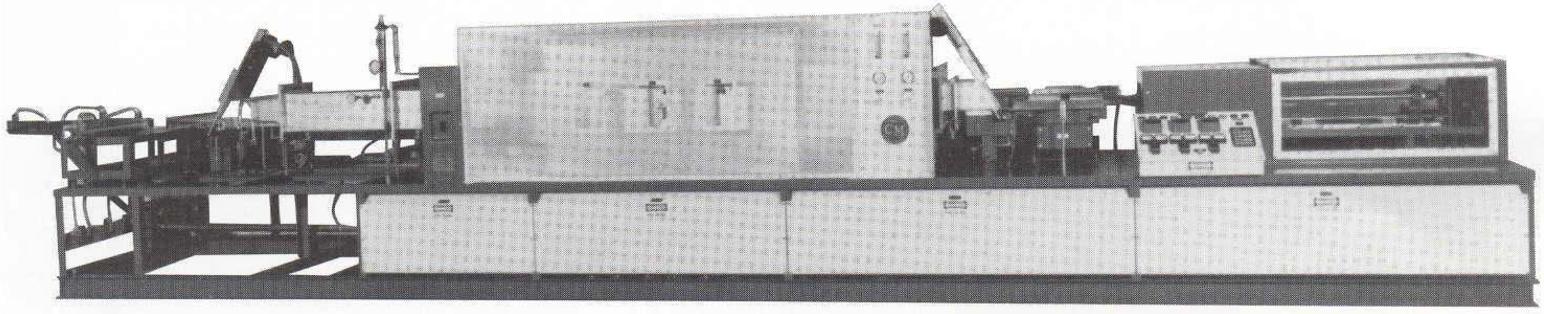
AVS Batch Furnace at PTI

High Vacuum, all metal hot zone for clean rapid cycles

Hydrogen, Argon, Vacuum cycles to 1450°C

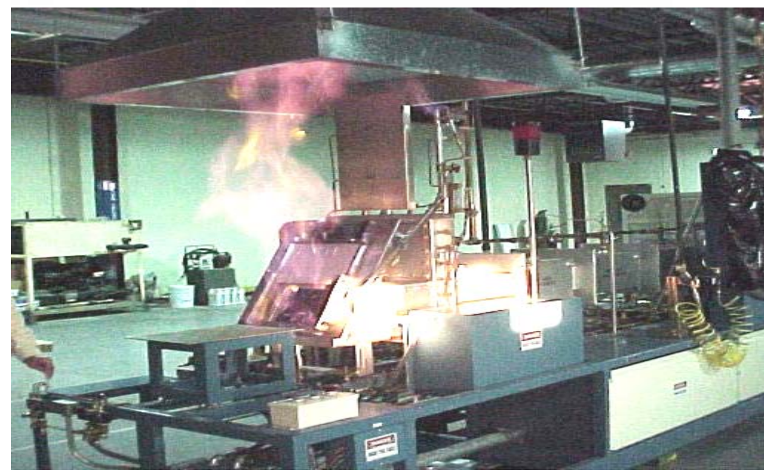


Hydrogen Pusher Furnace at PTI



300 Series Model 366 Automatic

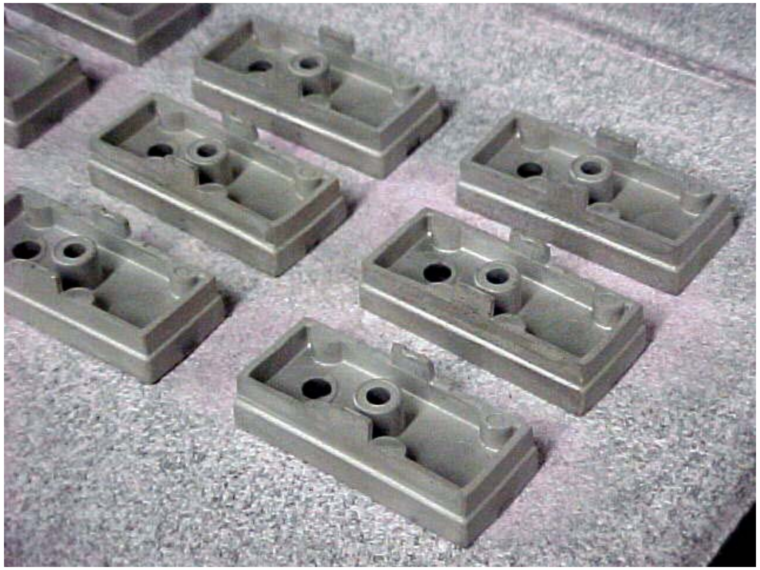
- High Production Rate Furnace
- 144" Preheat, 72" high heat, 96" cooling
- fully instrumented
    - (H_2 and N_2 mass flow meters, etc)
- 1650°C (~3000°F) operating temperature



CM Furnace for continuous production

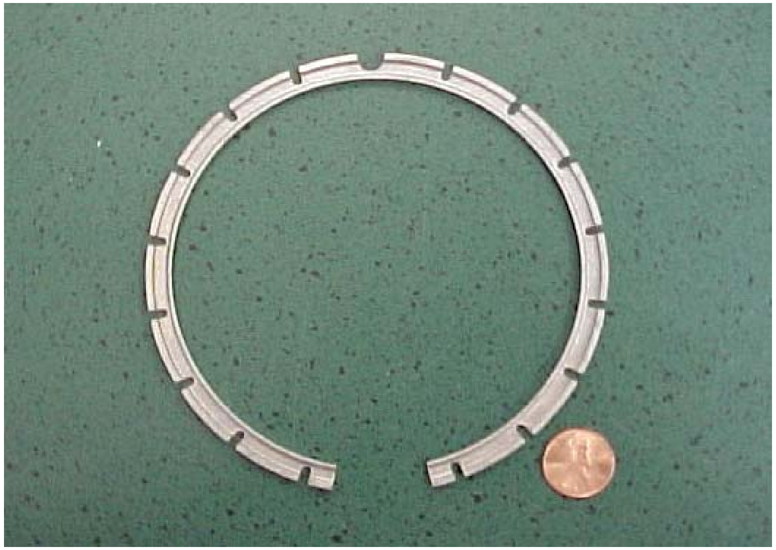
RR195 Backing Plate

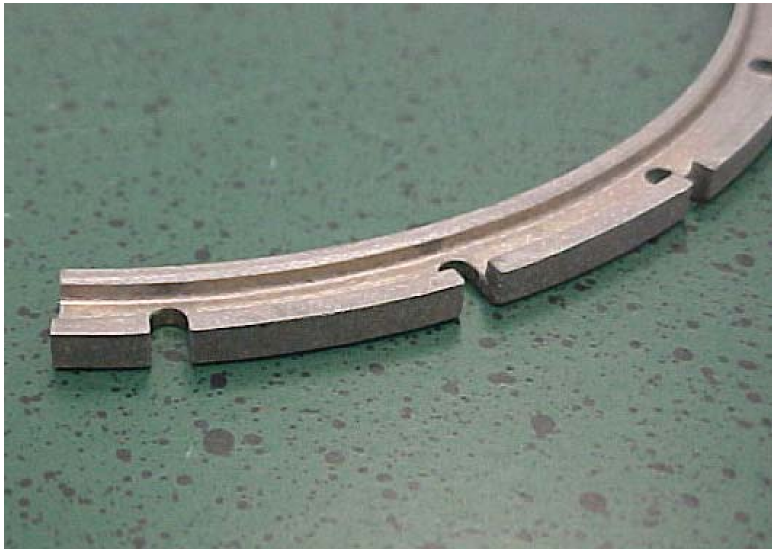
MIM 316L



17-4PH Stainless Steel Snap Ring

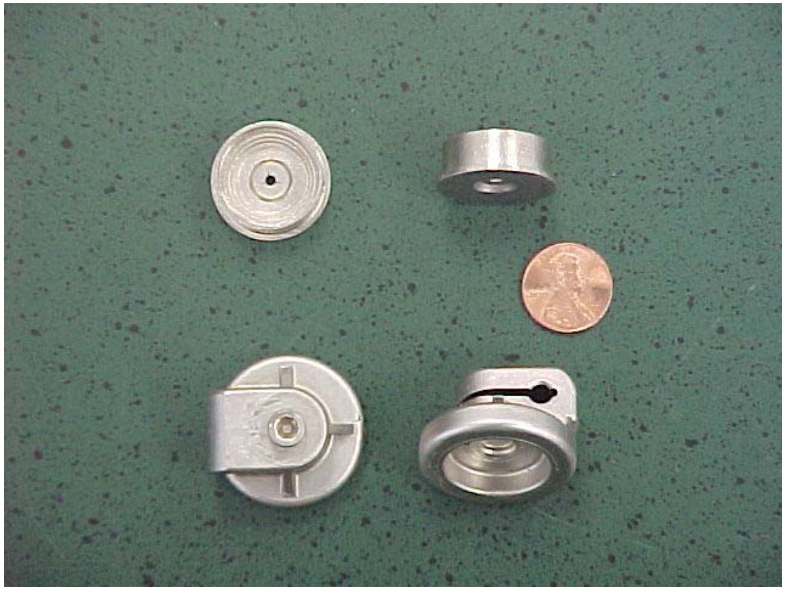
Flying Bomb Housing





Demonstrated ability to flow and fill long thin parts having detail

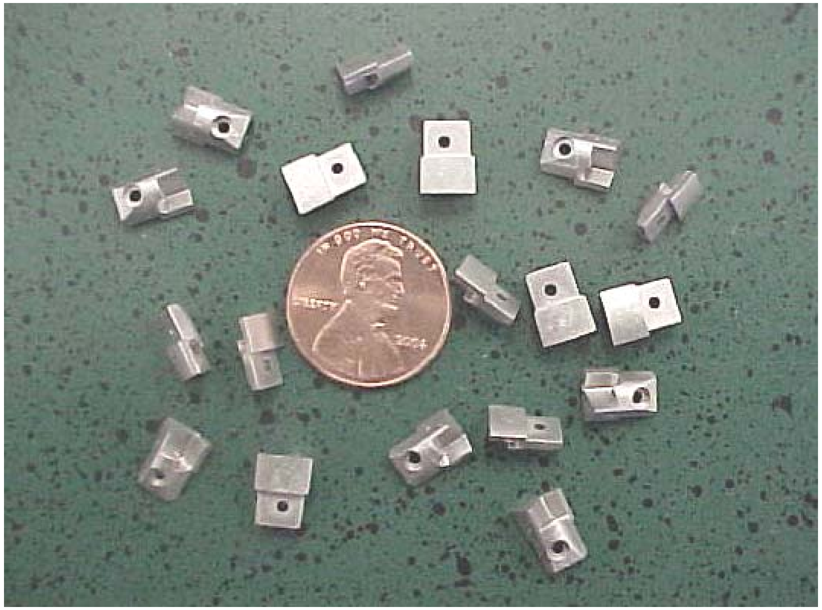
316L, 17-4PH and 4340 Components



Simple and Complicated shapes can be formed easily

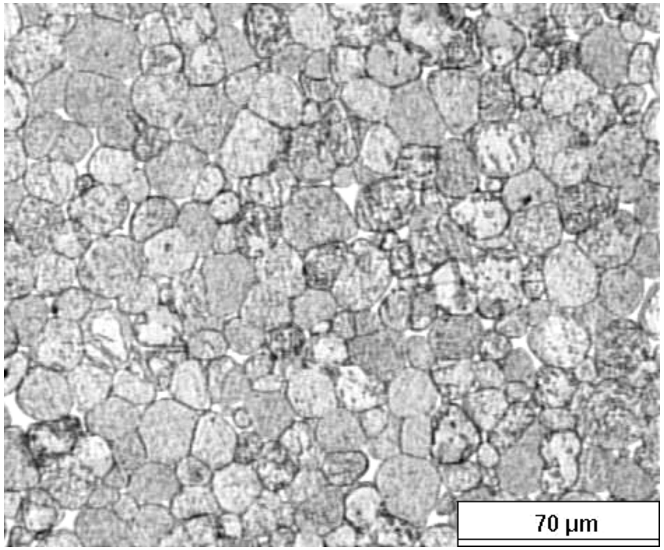
Tungsten Alloy Components

Balls

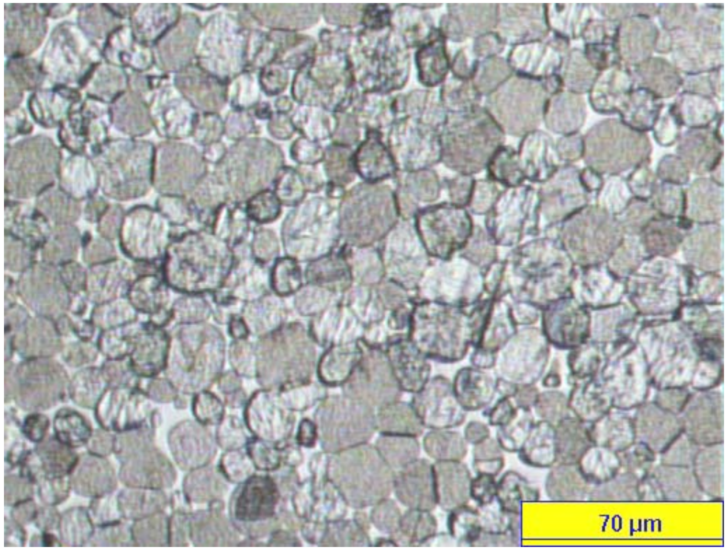


Flyweights

MIM of Tungsten Heavy Alloy



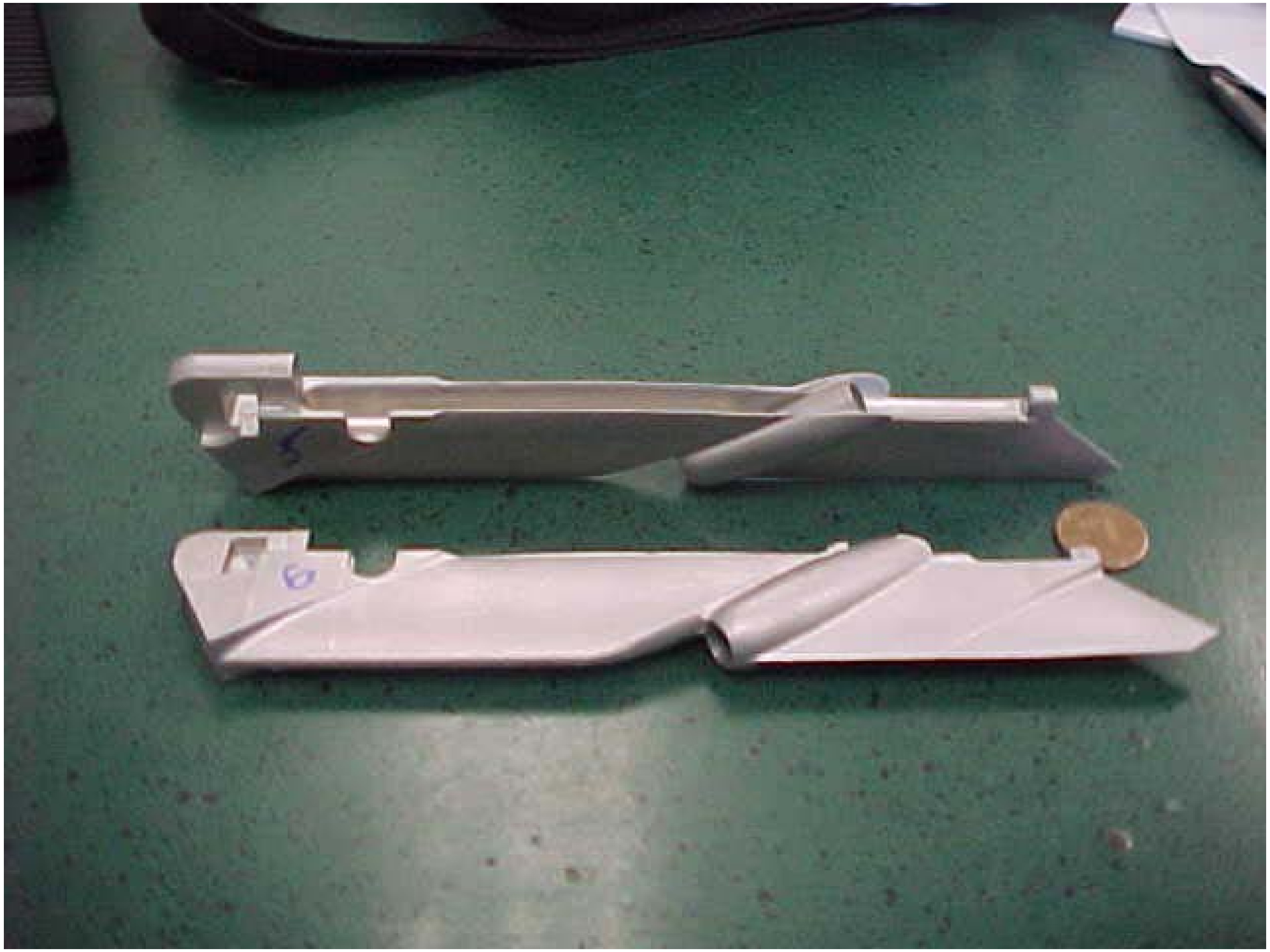
Baseline Press and Sinter



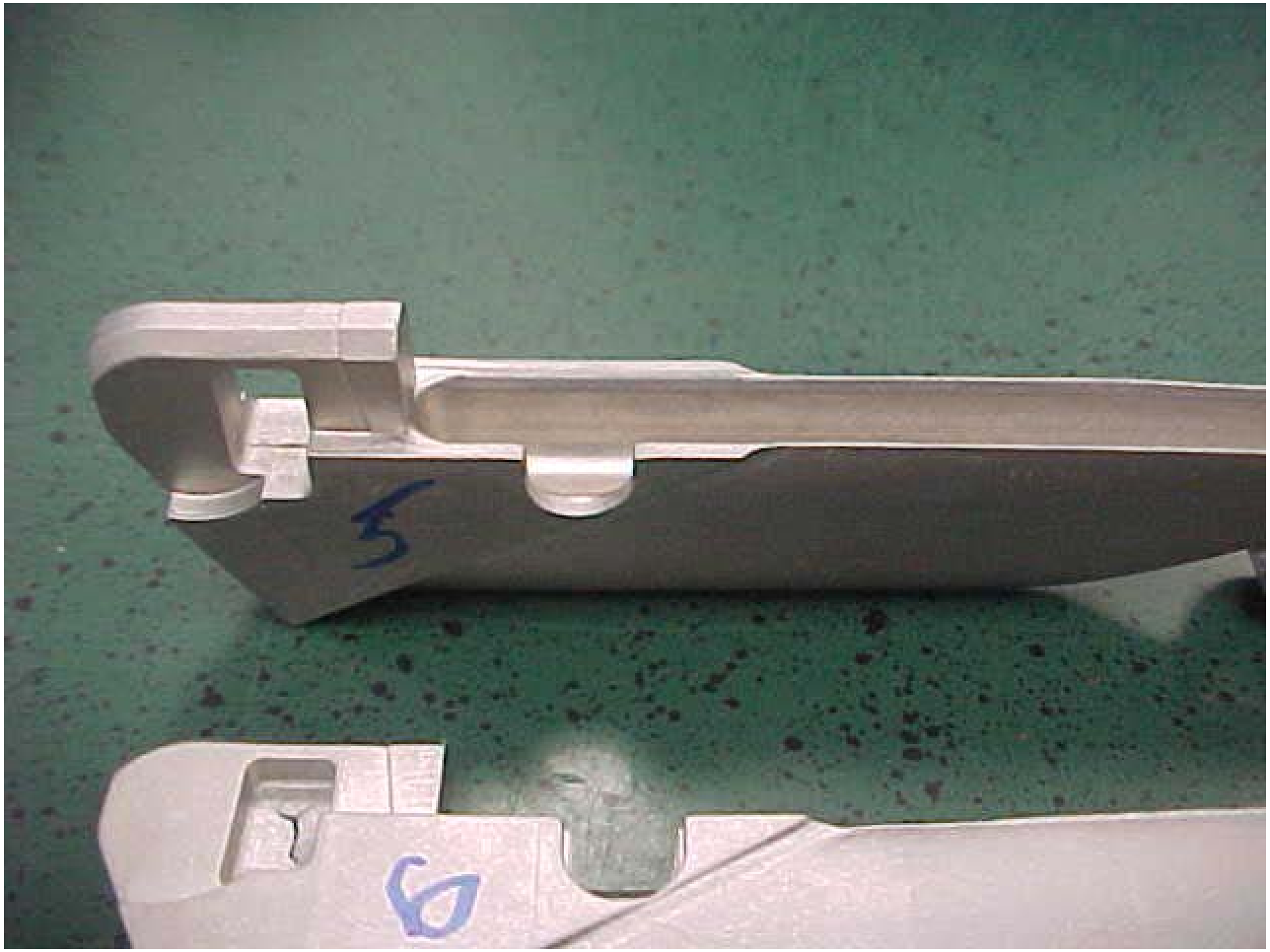
MIM Plate

PTI MIM has identical microstructure as traditional process

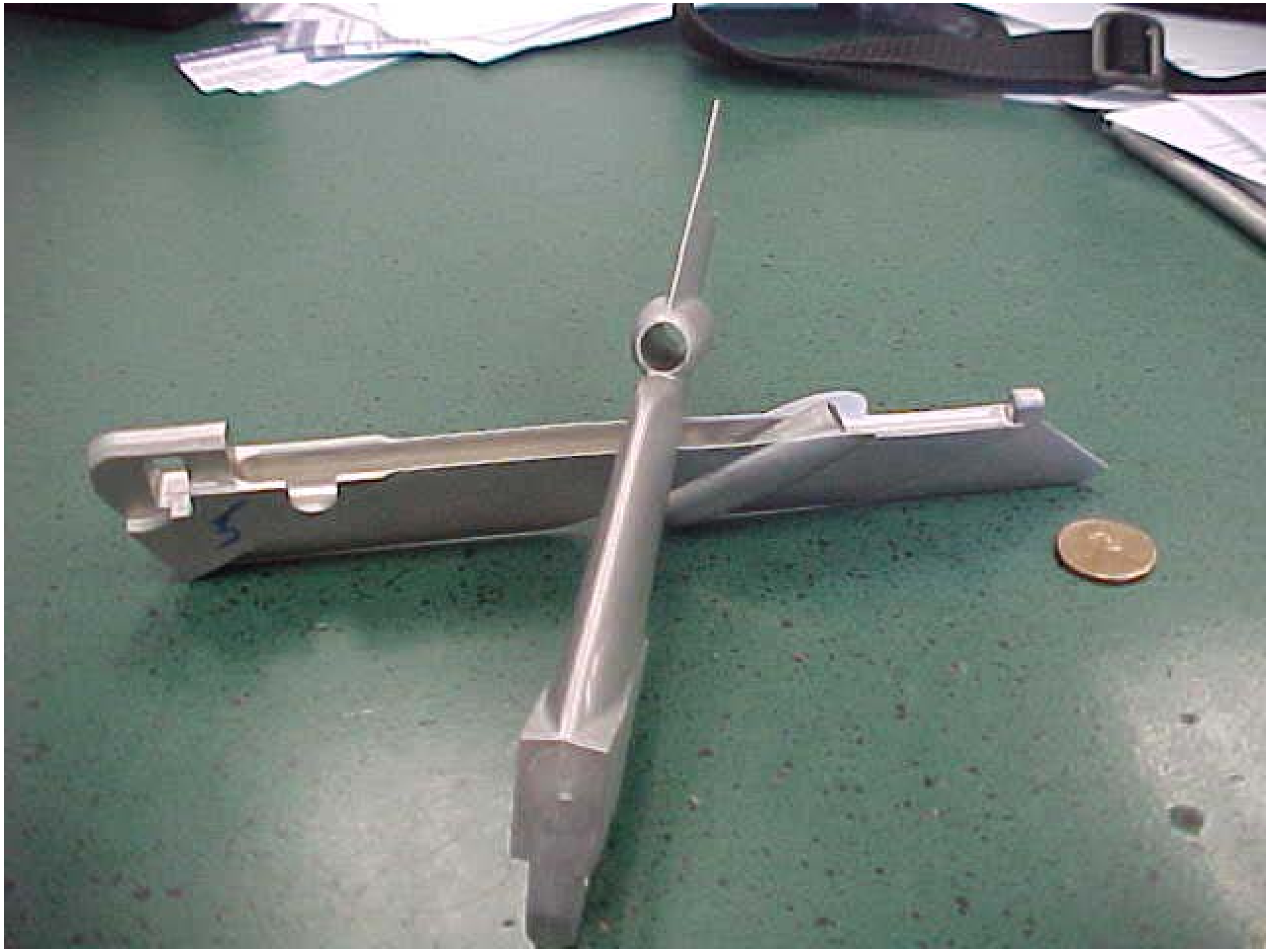
Complex Geometry and Co-Sintered Joints



As-Sintered 17-4PH MIM Wing

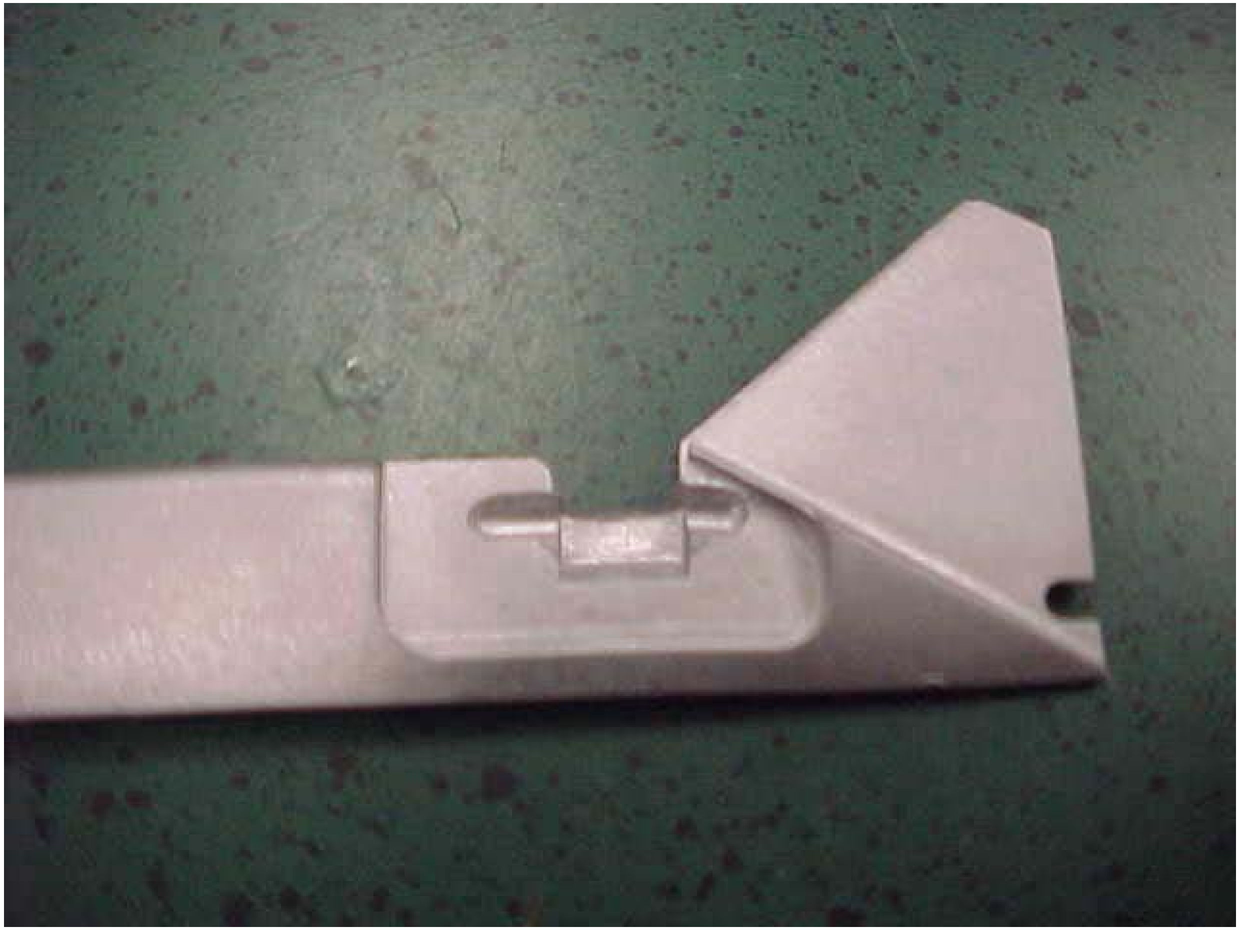


Closer view showing cavity on bottom



View through Nacelle

As-sintered 17-4PH Flaperon

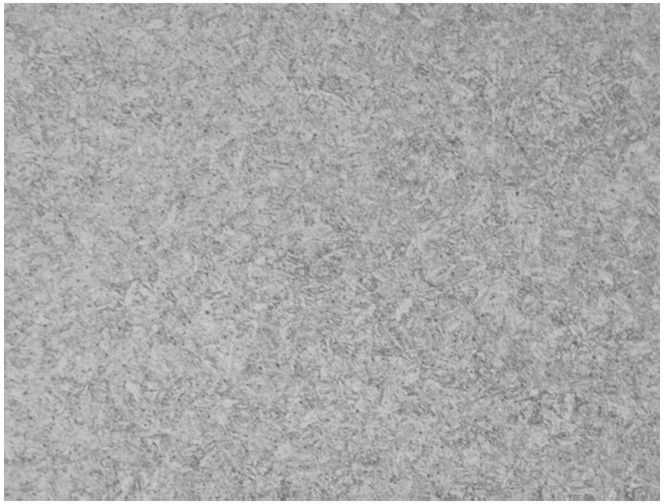


Closer view of back - As-sintered 17-4PH Flaperon

Phase I - Task I   Component Review -cont

17-4PH MIM Microstructures

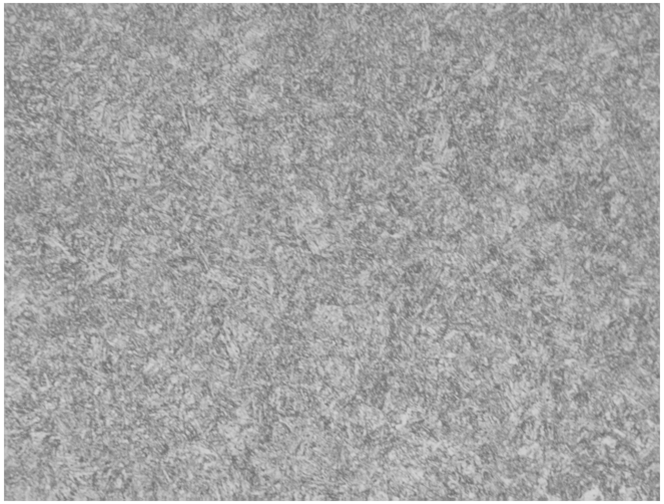
HIPed, standard H1025 H.T.



Edge of 5/8 inch dia bar

R_c =38

Cu=3.8



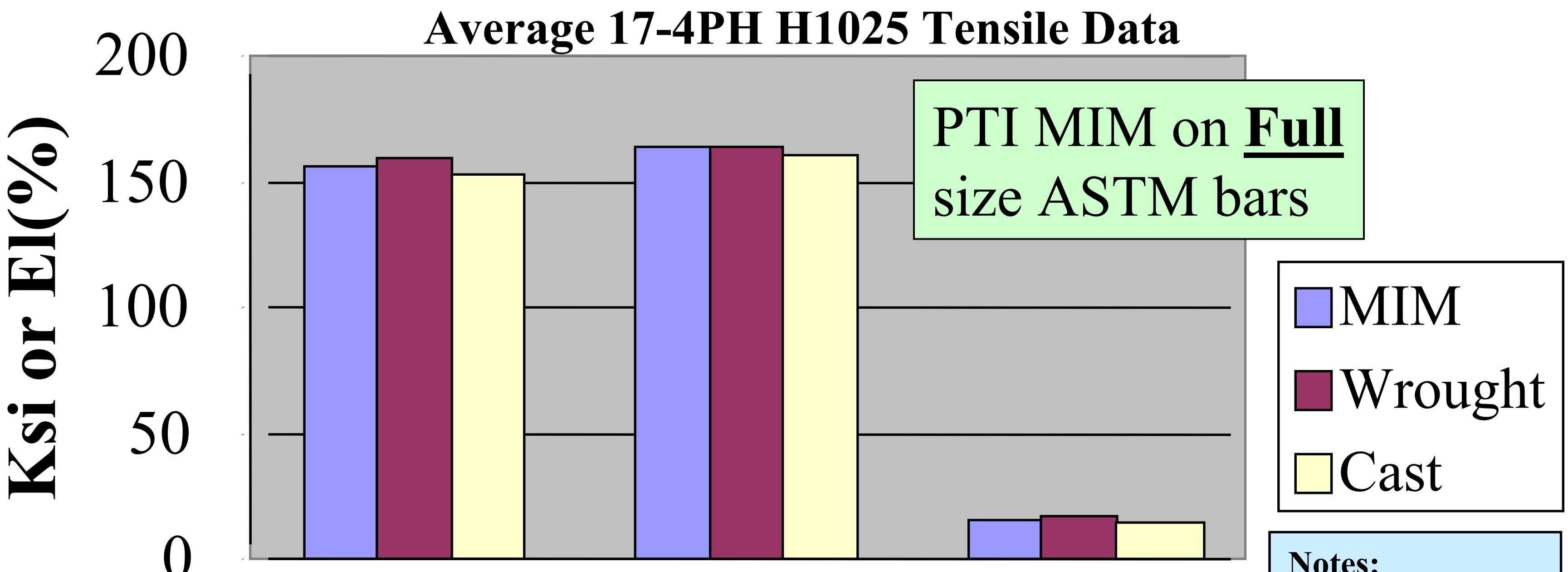
Center of 5/8 inch dia bar

R_c =38

Cu=3.8

Proper Control of Sintering Atmosphere Including Carbon Potential Allows for Uniform Properties in Thick Components

Phase I - Task I Component Review - cont



	YS(ksi)	UTS(ksi)	El(%)
MIM	153	165	12
Wrought	159	164	13
Cast	151	160	11

Notes:

unHIPed

C-0.03

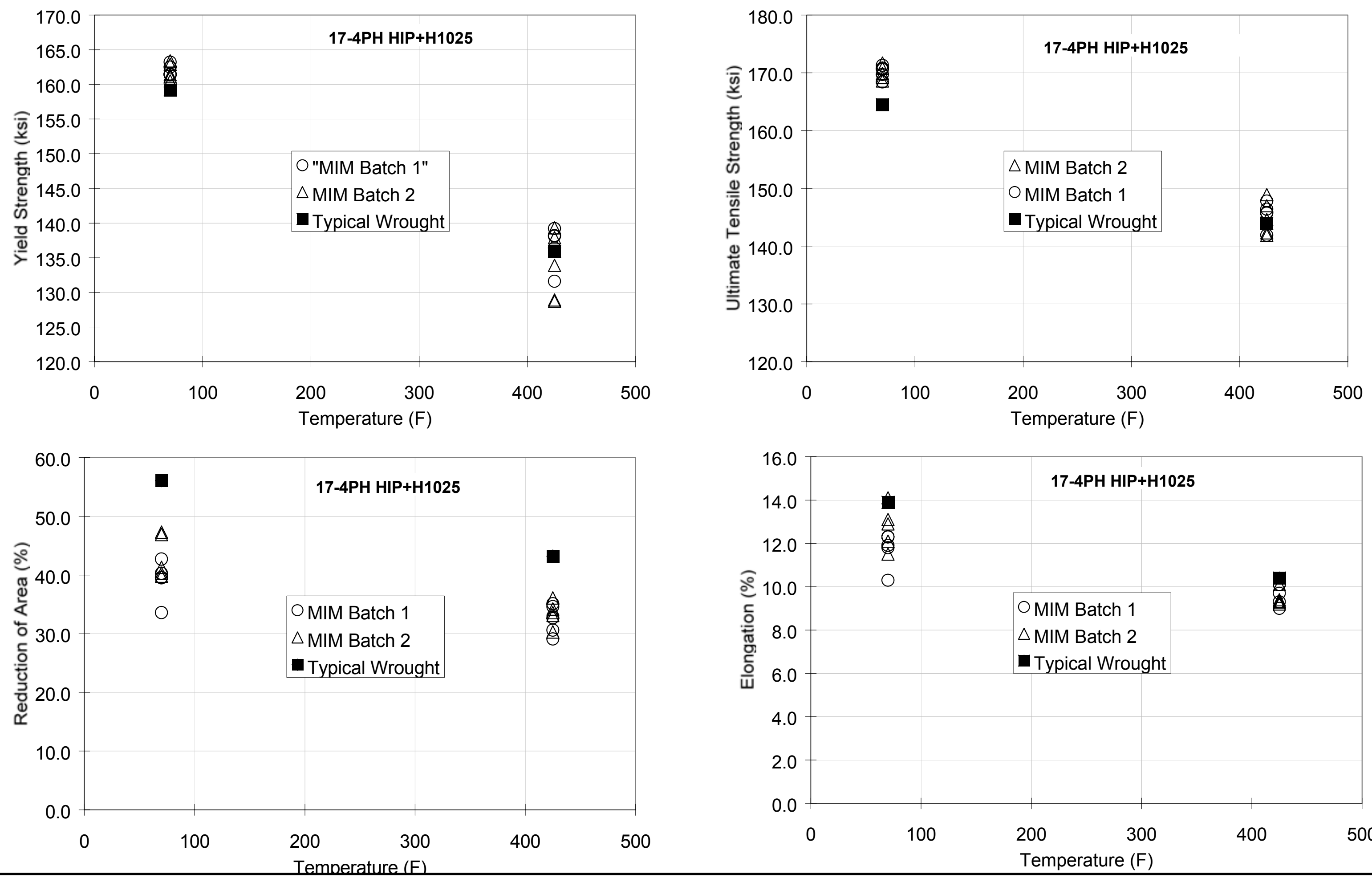
0xy-0.06

TD-99%

PTI MIM Tensiles are commensurate with Wrought specimens

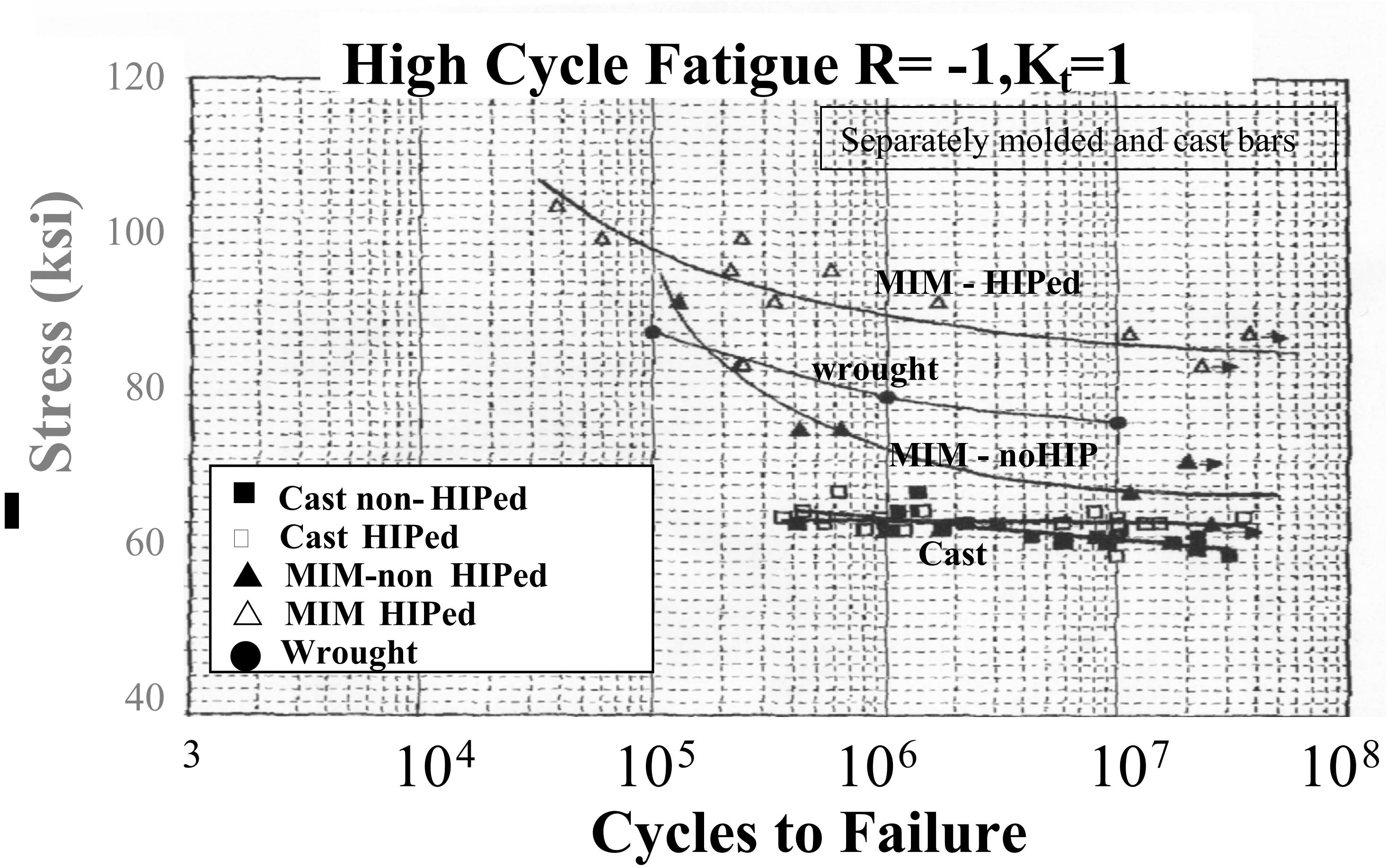
Tensile Comparison with Aerospace Wrought Data

HIPed H1025 17-4PH



PowderFlo Tensile Data is Equivalent to Aerospace Wrought Processed Material

High Cycle Fatigue R= -1,K_t=1



- MIM exceeds cast in all conditions
- MIM exceeds wrought in HIPed condition

MIM exceeds target goals of this program

Phase I - Task I Component Review – cont.

Typical Dimensional Tolerances

Feature	Best Possible	Typical
Angle	0.1°	2°
Density	0.2%	1%
Weight	0.1%	0.4%
Linear Dimension	0.05%	0.3%
Absolute Dimensions	0.04 mm	0.1 mm
Hole Diameter	0.04%	0.1%
Hole Location	0.1%	0.3%
Flatness	0.1%	0.2%
Parallelism	0.2%	0.3%
Roundness	0.3%	0.3%
Perpendicularity	0.1% or 0.1°	0.2% or 0.3°
Avg. Surface Roughness	0.4 μm	2 μm

Ref: R. German & R. Cornwall, The PIM Industry, Innovative Material Solutions, Inc., 1997.

Summary-Injection Molding at Polymer Technology

- Advantages of MIM
  - Cost Reduction-potentially 50% for the wing/flaperon
  - Component Flexibility
  - Ability to combine parts
  - Reduced Cycle Times, WIP
  - Ability to produce novel materials ability to reduce processing steps
- Advantages of MIM at PTI
  - Large components
  - Rapid Cycle time
  - Excellent properties in full scale components