Mechanical Properties Comparison between Metal Injection Molded (MIM) and 3D Printed (Printalloy®) 17-4PH components

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Advanced Powder Products, Inc (APP) produces metal components made by metal injection molding (MIM) and 3D printing of MIM powders (Printalloy®). MIM is a process that has been characterized extensively and the mechanical properties are documented in MPIF Standard 35. In this whitepaper APP has evaluated and compared mechanical properties of 17-4PHSS tensile bars made by both MIM and Printalloy®. Since MIM and Printalloy® use the same powders and the same sintering process, it is expected that mechanical properties of Printalloy® will meet MPIF Standard 35 values.

Experimental Procedure

MPIF Standard 50 tensile bars were fabricated using both MIM and 3D printed MIM 17-4PH SS powders and heat treated to H900 condition (Fig 1). MPIF Standard 35 17-4PH SS properties are shown in Table 1. Density, Chemistry, Carbon and Hardness were measured for both the MIM and Printalloy® test bars at APP. Tensile testing was performed by Westmoreland Mechanical Testing & Research using a test speed of 0.005 in/in/min and the results of UTS, 0.2% YS and elongation were reported according to ASTM E8-16a.

Figure 1. 17-4PH Tensile bars made by MIM (left) and Printalloy® (right)

Table 1: MPIF Standard 35 typical values for mechanical properties of MIM 17-4PH SS.

Alloy	Density (g/cc)	Hardness (HRC)	0.2% YS (ksi)	UTS (ksi)	Elongation (%)
MIM 17-4 PH (as sintered)	7.5	27	106	130	6
MIM 17-4 PH (H900)	7.5	33	158	172	6

Results

Chemistry

Table 2: Chemistry of MIM and 3D Printed 17-4PH SS Components.

Material 17-4 PH	Chemical Composition, % — Stainless Steels							
	Fe	Ni	Cr	C	Cu	Nb + Ta	Mn (max)	Si (max)
MPIF Standard 35	Bal.	3-5	15.5-17.5	0.07 (max)	3-5	0.15-0.45	1.0	1.0
MIM	Bal.	4.3	15.7	0.0072	3.2	0.31	0.6	0.4
Printalloy®	Bal.	4.3	16.7	0.022	4.1	0.32	0.3	0.3

Mechanical Properties

Table 3: Average H900 HT Mechanical Properties of MIM and Printalloy® 17-4PH SS compared to MPIF Standard 35 typical values.

Alloy	Density (g/cc)	Hardness (HRC)	0.2% YS (ksi)	UTS (ksi)	Elongation (%)
MPIF Standard 35	7.5	33	158	172	6
MIM	7.58	41.0	163.0	179.6	14.0
Printalloy®	7.63	38.5	160.7	180.6	10.3

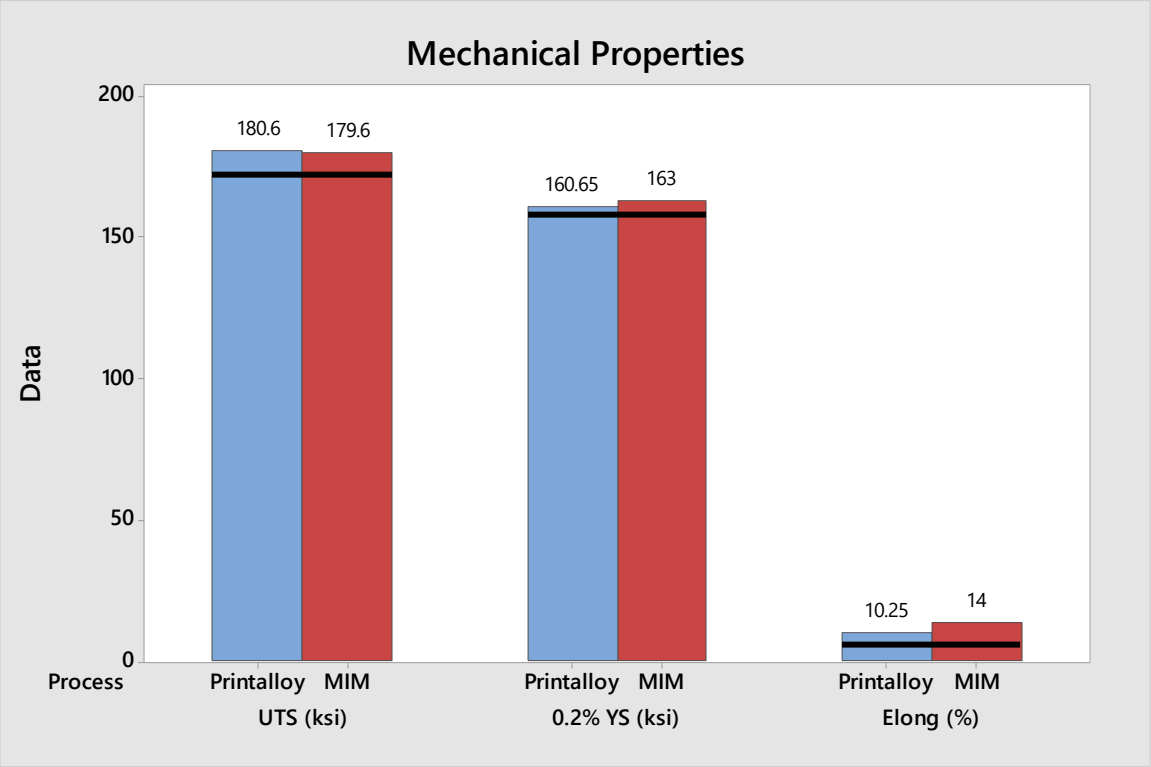

Figure 2. Tensile property comparison between 17-4PH SS H900 MIM and 3D printed components.

Figure 2 shows the mean of the overall tensile properties. Both MIM and 3D printing properties meet MPIF requirement for UTS, 0.2% YS and Elongation. Both processes have similar magnitude for this experiment, but 3D printing shows slightly lower ductility.

Conclusions

APP Printalloy® meets the chemical and mechanical requirements of MPIF Standard 35. The Printalloy® has slightly lower elongation as compared to MIM.

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