Comparison of Metal Injection Molding (MIM)

mechanical properties of low-alloy steels 4140 and 4605

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APP produces low alloy steels that meet the metallurgical properties of MPIF Standard 35 for metal injection molding. We recommend different alloys for different applications. This whitepaper compares MIM 4605 with MIM 4140 at two different heat treat conditions.

MIM-4605 and MIM 4140 are common low alloy steels used for structural application where high strength and hardness are necessary. Table 1 compares chemistry of both MIM made 4605 and 4140. The most notable difference between the two materials is the use of Cr instead of Ni in the 4140.

Table 1: Comparison of 4140 and 4605 Compositions.

Material Designation Code		Chemical Composition, % Low-Alloy Steels				
	Fe	Ni	Cr	Mo	C	Si (max)
MIM-4605	Bal.	1.5 – 2.5	-	0.2 – 0.5	0.4 – 0.6	1.0
MIM-4140	Bal .	-	0.8 – 1.2	0.2 – 0.3	0.3 -- 0.5	0.6

MPIF Standard 50 Tensile bars were made from both 4605 and 4140 by MIM and sintered to 7.60 and 7.58 g/cc density, respectively. They were then each quench and tempered to reach either 28-32 HRC or 40-45 HRC. Twelve bars of each material were tensile tested after heat treatment.

Table 2: MPIF Standard 35 Properties:

Alloy	Density (g/cc)	Hardness (HRC)	YS (ksi)	UTS (ksi)	Elongation (%)
4140 (Q&T)	7.5	46	155	200	3
4605 (Q&T)	7.5	48	190	215	<1

Figure 1-3 compare tensile properties.

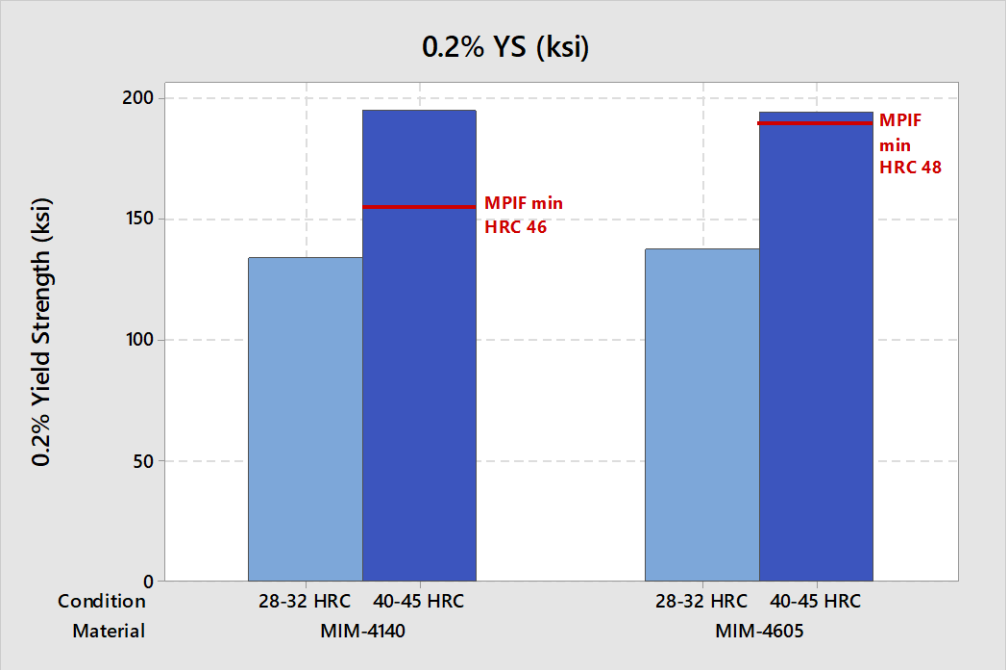

Figure 1. 0.2% Yield strength of MIM-4605 and MIM-4140 after heat treatment to 28-32 and 40-45 HRC

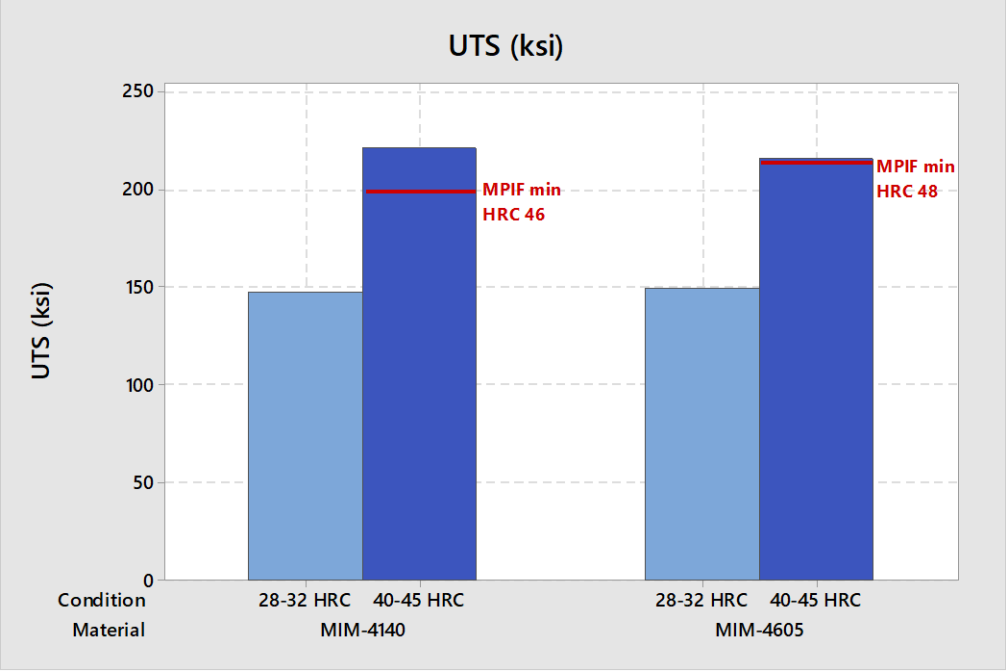

Figure 2. Ultimate Tensile Strength of MIM-4605 and MIM-4140 after heat treatment to 28-32 and 40-45 HRC

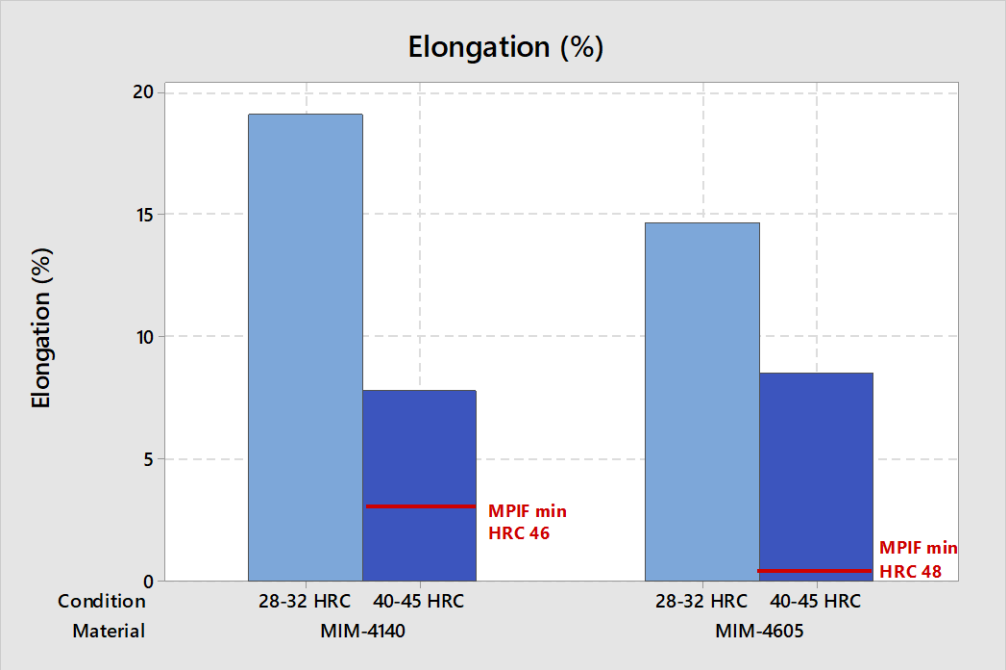

Figure 3. Elongation of MIM-4605 and MIM-4140 after Q&T to 28-32 and 40-45 HRC.

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