

### 2020 INDEPENDENT HIP STUDY

# HIP'ing Yields Greatest Tensile Strength for AlSi10Mg Components Produced Using Additive Manufacturing.

BY WARREN MIGLIETTI, PH.D., FALL 2020

Aluminum alloy AlSi10Mg can be used for manufacturing functional components. Table 1 shows the chemistry/composition which meets the ASTM F3318 specification.

Three heat treatments were conducted on the AM coupons as shown below:

1. AS BUILT (no heat treatment)
2. STRESS RELIEF #1: 518°F, 2 hours
3. STRESS RELIEF #2: 572°F, 2 hours
4. HIP'ed: proprietary parameters

Table 2 shows the Tensile Properties produced in the AM coupons as a result of the 3 heat treatments.

As can be seen in Table 2, the HIP'ed heat treatment yielded the best tensile properties of the AM Alloy AlSi10Mg coupons.

ELEMENT	RANGE (WT%)
Al	Balance
Cu	0.00-0.05
Fe	0.00-0.55
Mg	0.20-0.45
Mn	0.00-0.45
Ni	0.00-0.05
Si	9.0-11.0
Zn	0.00-0.10
Ti	0.00-0.15
Pb	0.00-0.05
Sn	0.00-0.05
Other (each)	0.00-0.05
Other (total)	0.00-0.15

**TABLE 1: Compositional range of AlSi10Mg alloy**

**TABLE 2: Comparison of Tensile Strengths of As-built vs 3 post-built heat treatments**

HEAT TREATMENT	ULTIMATE TENSILE STRENGTH	YIELD STRENGTH	ELONGATION
AM + As-built	67.4 ksi	35.5 ksi	7.4 %
AM + 518°F / 2 hours	51.4 ksi	32.6 ksi	8.2 %
AM + 572°F / 2 hours	40.6 ksi	24.6 ksi	14.5%
AM + HIP'ed	74.3 ksi	43.5 ksi	6.0 %

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## About the Author

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*Dr. Miglietti is currently the President and Principal Metallurgical Consultant of Miglietti and Associates, LLC, a consultancy company based in Kansas City, Missouri. Prior to this he was Director of Repair Technology at ProEnergy and worked for 7 years at PSM-An Alstom Company. In addition he worked for 5 years at GE's Repair Development Center and 5 years for Sermatech International as a process repair engineer and as a component repair engineer respectively. His principal responsibility was the development of novel repair techniques and processes for components, operating in advanced land-based gas turbine engines, such as the Frame 7FA.03, GT24/26 and W501F/M501F engines. He has over 30 years of experience*

*and expertise in the Welding (GTAW and Laser), Brazing (Narrow and Wide Gap Diffusion), FIC, Acid Stripping and Heat Treatment of Ni and Co-base superalloys. Dr. Miglietti is the outgoing chairman of the Commission XVII – "Brazing and Diffusion Bonding" of the International Institute of Welding (IIW) and was past chairman of the Manufacturing, Materials and Metallurgy Committee of IGTI, an affiliate of ASME. He has authored or co-authored 47 technical papers and has 13 repair technology patents. Today, he has a strong focus on assisting clients with materials characterization and mechanical property evaluation of Additive Manufactured/3D printed components, as well as providing heat treatment information for these components.*

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