

2020 INDEPENDENT HIP STUDY

HIP'ing Yields Greatest Tensile Strength for Inconel 625 Components Produced Using Additive Manufacturing.

BY WARREN MIGLIETTI, PH.D., FALL 2020

Inconel 625 is one of the most popular Ni-based solid solution strengthened alloy and is used for manufacturing functional components. Table 1 shows the chemistry/composition of Inconel 625.

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

1. AS BUILT (no heat treatment)
2. STRESS RELIEF: 1950°F, 1.5 hours
3. SOLUTION HEAT TREATED: 1900°F, TIME COMMENSURATE WITH THICKNESS PER AMS 5599
4. HIP'ed: proprietary parameters

As can be seen in Table 2, the HIP'ed heat treatment yielded the best tensile properties of the AM Alloy Inconel 625 specimens.

ELEMENT	RANGE (WT%)
Ni	Balance
C	0.1 max
Si	0.5 max
Mn	0.5 max
P	0.015 max
S	0.015 max
Cr	20.00 – 23.00
Mo	8.00 – 10.00
Fe	5.00 max
Nb	3.15 – 4.14
Al	0.4 max
Ti	0.4 max

TABLE 1: Compositional range of Inconel 625 alloy

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

HEAT TREATMENT	ULTIMATE TENSILE STRENGTH	YIELD STRENGTH	ELONGATION
Wrought Sheet/plate	120 ksi	60 ksi	30 %
AM + As-built	146 ksi	97 ksi	42 %
AM + Stress Relieved	138 ksi	93 ksi	36 %
AM + Solution heat treated per AMS 5599	128 ksi	61 ksi	41%
AM + HIP'ed	150 ksi	99 ksi	40 %

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About the Author

Warren Miglietti, Ph.D. - President and Principal Metallurgical Consultant of Miglietti and Associates, LLC



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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SOUTH CAROLINA

Brent Davis
Vice President
299 B Garlington Road
Greenville, SC 29615

W (864) 213-9310
C (864) 423-6625
brent.davis@accuratebrazing.com

NEW HAMPSHIRE - HQ

Hazen Earle
Northeast Regional Manager
36 Cote Avenue
Goffstown, NH 03045

W (603) 945-3761
C (603) 235-4502
hazen.earle@accuratebrazing.com

CONNECTICUT

Bob Sartori
General/Operations Manager
4 Progress Drive
Manchester, CT 06042

W (860) 432-1840
C (860) 306-3628
bob.sartori@accuratebrazing.com

