Weldability Aspects of Additive Manufactured Superalloys

Joel Andersson[*,1]

[*]Department of Engineering Science, University West
46181 Trollhättan, Sweden
joel.andersson@hv.se

ABSTRACT

The Ni-based and Fe-Ni-based superalloys are readily used in aero-engines and specifically the hot section which serves as the most challenging application for materials. It is therefore of high importance that the welds used in the design are of suitable quality to account for the demanding environment. Despite these challenges, fabrication in which welding is commonly utilized is being more and more employed to tailor structural fabrications in an improved manner to reduce weight as well as to increase performance of aero-engines. The trend of increased share of fabrication emphasizes the importance of understanding welding and the associated metallurgy. The importance of weld associated concerns can be furthered coupled with a tremendous boost in interest of additive manufacturing (AM) which is very linked to welding and where the lessons learned in welding can and should be used for AM. Looking at the number of publications that has developed during the years it can be clearly seen that both welding as well as AM of superalloys are still increasing [1, 2], Figure 1.

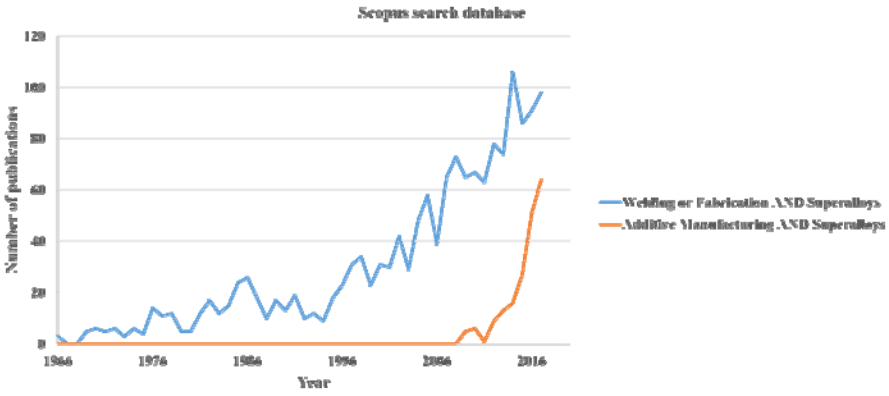

Figure 1: Amount of publications versus years for welding as well as additive manufacturing of superalloys [1, 2].

There are numerous of challenges in fabrication of hot structural components where hot cracking is one issue which should not be underestimated [3]. By replotting Varestraint weldability data performed by Raza et al [4] and Singh et al [5] on wrought, selective laser manufactured and cast Alloy 718 in various conditions it can clearly be seen that the hot cracking response differs significantly, Figure 2.

[1] Joel Andersson

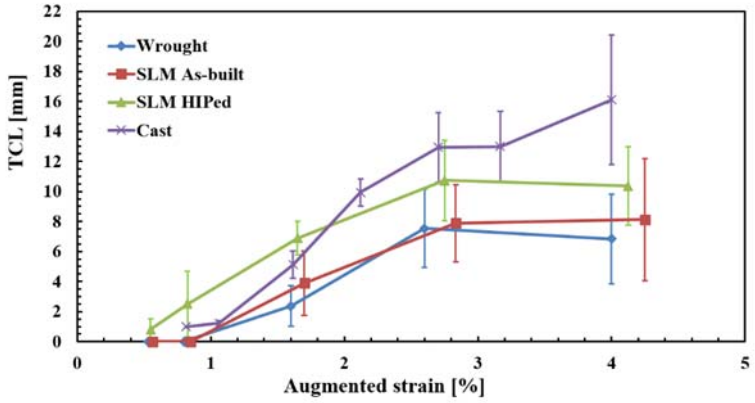

Figure 2: Varestraint test results of Alloy 718 in the wrought, cast and selective laser manufactured (SLM) conditions replotted from [4, 5]. The SLM material form was in the as manufactured and hot isostatic pressed (HIP) conditions.

It can be seen that the hot cracking susceptibility is worst for the cast material form and that it increases in the HIP'ed SLM condition as compared to the as manufactured SLM condition. The as manufactured SLM condition seem to be at pair with the wrought Alloy 718 in terms of susceptibility towards hot cracking. Overall, the grain size seem to be an important parameter in reducing hot cracks.

References

[1] Scopus.com, (2017). Analyze Results - Welding or Fabrication and Superalloys. Available at: http://www.scopus.com' [Accessed: 2017-12-26].

[2] Scopus.com, (2017). Analyze Results - Additive Manufacturing and Superalloys. Available at: http://www.scopus.com' [Accessed: 2017-12-26].

[3] J. Andersson; "Review of weldability of precipitation hardening Ni- and Fe-Ni-based superalloys", Proc. 9th Int. Symp. Superalloy 718 Deriv. The Minerals, Metals & Materials Society; 2018.

[4] T. Raza, J. Andersson, and L-E. Svensson; "Varestraint weldability testing of additive manufactured Alloy 718", Science and Technology of Welding and Joining, submitted, 2018, DOI: 10.1080/13621718.2018.1437338.

[5] S. Singh, and J. Andersson; "Hot Cracking in Cast Alloy 718", Science and Technology of Welding and Joining, 2018, DOI: 10.1080/13621718.2018.1429238.