

인코넬 718합금의 고온성형 및 접합공정 연구 High Temperature Blow Forming And Bonding of INCONEL 718 Alloy

*#권용남¹, 홍성석², 김흥규²

* #Y.-N. Kwon¹(kyn1740@kims.re.kr), S. S. Hong², H. G. Kim²

¹한국기계연구원 부설 재료연구소, ²국방과학연구소

Key words : INCONEL 718, blow forming, diffusion bonding

1. Introduction

Superplastic forming is an ideal process for manufacturing complex shaped parts with fine grained materials. It has been used extensively for producing light weight components for aircraft mostly with Ti alloys. Also, superplastic formed components show enhanced performance and reliability over mechanically joined parts while lowering overall manufacturing cost by reducing the need for extensive welding or other joining methods. It also can simplify the component design and manufacturing process by accompanying diffusion bonding process.

High temperature deformation and bonding characteristic of INCONEL 718 alloy sheet with the grain size of $15\mu\text{m}$ was investigated in order to get enough information on processing condition of blow forming and diffusion bonding process.

2. Blow forming

In the present study, INCONEL 718 alloy sheet with the grain size of $15\mu\text{m}$ was used as shown in Fig. 1. Stress-strain rate curves at the temperature between 900 and 980°C were collected using strain rate jump test in order to investigate the optimum condition for blow forming, which is usually known as $m > 0.5$. Even though the relatively small grain size, strain rate sensitivity as shown in Fig. 2 was determined as 0.08~0.4, which was much lower than 0.5 that has been known to be a requirement for stable superplastic deformation. Also, blowing into cylindrical cavity was tried to investigate biaxial formability of INCONEL 718 alloy. Blow formability which was determined using maximum forming height was well

corresponded with tensile elongation, which again showed the limited values compared with other small grained superplastic materials. Also, blow formed specimen showed the severe cavitation which suggested a difficult grain boundary sliding which is considered as one of dominant deformation mechanisms of small grained materials at high temperature.

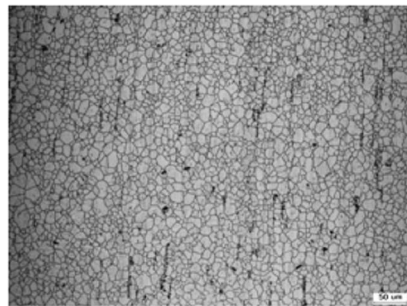


Fig. 1. Optical microstructure of INCONEL 718 alloy along rolling direction.

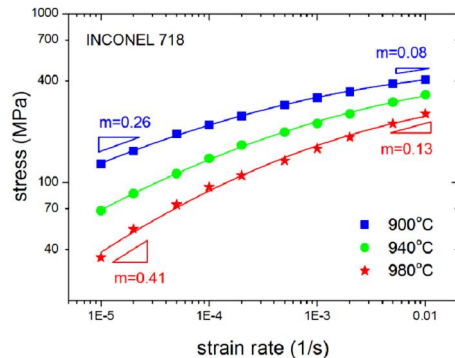


Fig. 2 Stress-strain rate curves of INCONEL 718

It is noteworthy that longer forming time induced

precipitation of Nb-containing particles which subsequently resulted in lowering formability of INCONEL 718 at the elevated temperature.

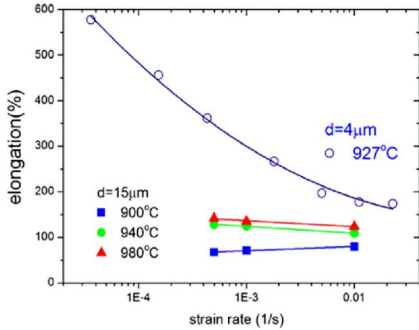


Fig. 3 Elongation of INCONEL 718 with the grain size of 15 μm

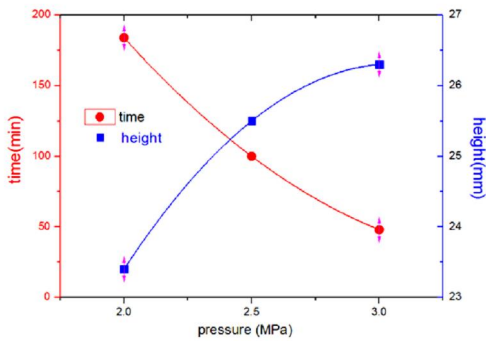


Fig.4 Blow forming result INCONEL 718 sheet with different pressure at 950°C

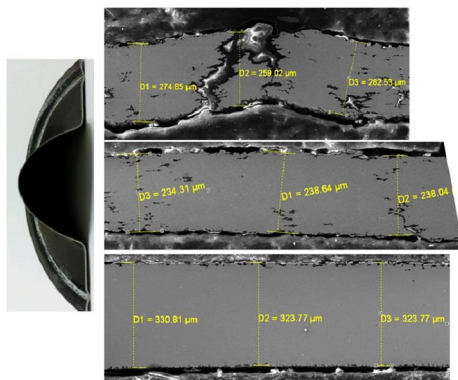


Fig. 5 Microstructure after blow forming shows severe cavitation

3. Diffusion bonding

Diffusion bonding of INCONEL 718 alloy sheet was tried with variation of temperature, time and pressure. Also, bonding surface was modified with plating Ni-P layer with the thickness of about 10 μm. Fig. 6 shows bonded layer after diffusion bonding at 940°C for 1hr. This processing condition brought out a perfect bonding except a few cavities along the original surface of each sheet. Generally, Ni-P coated sheet was bonded with lower pressure as well as in lower temperature. Bonding time did not seem to give much effect on bonding strength.

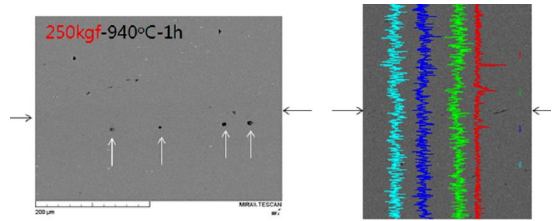


Fig. 6 Bonding layer of INCONEL718 showed perfect bonding.

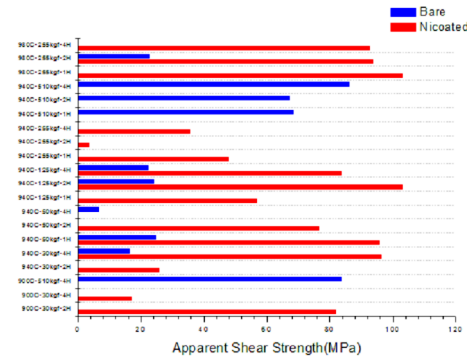


Fig. 7 Bonding strength of INCONEL718 tested with angle shear test

4. Conclusion

Blow forming and diffusion bonding characteristics of INCONEL 718 alloy sheet with the grain size of 15 μm was investigated in this study. Even though the grain size was not small enough, a component can be made by blow forming and diffusion bonding.