Ring Casting Cracking Test에 의한 용접균열 감수성 평가

김 환 태

한국기계연구원 용접기술연구부

1. Introduction

In the previous report the effect of alloying elements on the solidification cracking susceptibility of aluminum alloy was investiated by GTAW crater cracking test and it was found that manganese and zirconium are beneficial to decrease the solidification cracking susceptibility. It was also made clear that the self restraint test method of GTAW crater cracking test showed the same tendency in results as the external restraint test.

The solidification cracking test methods can be divided to two types, as previously mentioned, self restraint and external restraint type, and the self restraint test method can duplicate conditions more closely related to actual welding situations where the restraint is imposed on the structure.

In this experiment another approach has attemped to evaluate both methods comparatively, ring casting cracking test and TIG-A-MA-JIG varestraint cracking test.

2. Experimental procedure

The self restraint method of the ring casting cracking test was used under the test condition of 750℃ at pouring temperature of melts and 50℃ of the preheating of the ring mold of which inner diameter was 35 mm. Total

length of cracks observed on the surface of the ring-casted metal was used as the criteria to evaluate the solidification cracking susceptibility in the casting. The number of the reptition of cracking test was 7 to 8 times for each testing alloy.

3. Experimental Results and Discussions

In order to evaluate the effect of additional alloying elements in reducing the solidification cracking tendency of the 7000 series high strength aluminum alloy, the self restraint type ring casting test results were analysed, and these results were compared to those of the external restraint type TIG-A-MA-JIG varestraint cracking test. Zirconium and manganese showed beneficial effects in reducing the solidification cracking susceptibility and macrostructural observation of ring casted metal showed small grain size. On the contrary , chromium showed almost no effect and copper showed detrimental effect to the solidification cracking susceptibility. The macrostructure of these casted metal showed larger grain size than those of zirconium and manganese added metal. Metallographic examination of varestraint cracking test shows that the solidification cracking is intergranular and/or interdendritic along crack -sensitive grain boundaries.

Weld metal solidification cracking is found to be associated with the microsegregation which occurred at the grain boundaries during the rapid solidification of the welding process. Examination of the weld metal microstructure also indicates the intermetallic second phase constituents, the shapes of which are almost globular, are scattered along the grain boundaries. The fractured surface was observed and 3 types of fracture mode

occurred. Type I has the primary and the secondary arms of the dendrites, and the mode is almost globular with the characteristic feature of the dendritic protuberance appearances. Type II shows the growth direction of the primary and the secondary arms is parallel to the growth direction of the columnar grain, and the morphology of the secondary arms of the dendrites became indefinite with the characteristics feature of the flat protuberance appearance. Type III shows the primary dendrities and the growth direction of grains can be still observed but the secondary arms of the dendrites could not be distinguished, and the surface of the primary arms of the dendrites are considerably smooth with the characteristic feature of the dendritic columnar appearance.

4. CONCLUSION

The susceptibility to solidification cracking of the 7000 series Al-Zn-Mg alloys has been investigated using the self restraint and external restraint test method, and the results of ring casting cracking test and TIG-A-MA-JIG varestraint cracking test show the same trend. It is found that the solidification cracking susceptibility of ring casting closely connected with the grain size of the casted metal. The fracture mode of the solidification cracks under the optimum amount of Mn are dendritic type protuberance for the alloy with a low Zr concentration, flat type protuberance for the alloy with a low Cr concentration, and dendritic columnar type protuberance for the alloy with a high Cr concentration, respectively.