The initiation of stress corrosion crack in Alloy 718 under pressurized water reactor primary water conditions

Haipeng Zhu[1,2], Zhiming Zhang[3], Jianqiu Wang[1,2,3], En-hou Han[1,3]

[1]*CAS Key Laboratory of Nuclear Materials and Safety Assessment, Institute of Metal Research, Chinese Academy of Sciences, Shenyang, 110016, P. R. China*

[2] *School of Materials Science and Engineering, University of Science and Technology of China, Shenyang, 110016, P. R. China*

[3] *Institute of Corrosion Science and Technology, Guangzhou, 510530, P. R. China*

hpzhu20s@imr.ac.cn

Abstract Stress corrosion crack initiation behavior of alloy 718 was investigated through slow strain rate tensile (SSRT) test. Alloy 718 was subjected to two commercial heat treatments. Specimens solution-treated at 1080 °C exhibit precipitation of the γ′ and γ″ phase, ensuring the material possesses outstanding mechanical properties. This heat treatment method is characterized by a low sensitivity to stress corrosion. Conversely, specimens subjected to solid solution treatment at 970 °C demonstrate an increased propensity for stress corrosion cracking due to the additional precipitation of the δ phase. Grain boundaries, MX phases, and delta phases are susceptible to preferential oxidation, making them the prime sites for crack initiation.

Keywords Alloy 718; Stress corrosion cracking; Pressurized water reactor

Reference

[1] Z. Ning, H. Zhang, S. Zhang, X. Hao, E.-H. Han, W. Kuang, Effects of precipitation on the stress corrosion crack initiation of alloy 718 in simulated pressurized water reactor primary environment, Acta Materialia 276 (2024).

[2] M. Wang, M. Song, G.S. Was, J.L. Nelson, The roles of thermal mechanical treatment and δ phase in the stress corrosion cracking of alloy 718 in primary water, Corrosion Science 160 (2019).

[3] K.J. Leonard, M.N. Gussev, J.N. Stevens, J.T. Busby, Analysis of stress corrosion cracking in alloy 718 following commercial reactor exposure, J Nucl Mater 466 (2015) 443-459.