Creep behavior of GH3535 Ni-based superalloy in Ar and FLiNaK molten salt environment

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Abstract High temperature molten salt reactor is one of the fourth generation reactors, the structure material of which is GH3535 superalloy. GH3535 alloy is subjected to molten salt corrosion and local stresses, so the alloy may crack during service. This will affect the service life of the alloy and the safety of reactor operation. Therefore, the mechanical behavior evolution and mechanism of GH3535 alloy in the molten salt need to be clarified.

The creep deformation and fracture behavior of GH3535 alloy under different stress (190MPa, 235Mpa and 270MPa) in 700 ^{o}C molten salt and Ar environments was investigated. The minimum creep rate in molten salt is larger than that in Ar and the creep rupture life is shorter in molten salt than that in Ar. Furthermore, under the stress lower than the 220 MPa yield strength, the alloy creep fracture life and elongation in molten salt are both significantly lower than that in Ar. The alloys exhibit a combination of ductile overload and intergranular fracture in both environments, intergranular cracks are formed on the surface and inside of the alloy, but the crack density and depth are larger in the molten salt.

In both environments, the processing layer on the surface of the alloy is tempered and recrystallized at 700 ^{o}C form a fine crystal layer. The deformation area below the fine crystal layer first cracks initiation under the stresses and expands to the alloy matrix. However, due to the corrosion of the molten salt, Cr loss occurs on the surface of the fine crystal layer, thus connecting with the cracks in the lower layer to form a penetrating crack. The entry of molten salt into the cracks, causing more cracks to form and the elements along the cracks to diffuse to the alloy surface, crack propagation depth is also deeper.