Understanding the effect of surface machining on corrosion behavior of Ni-based alloy GH3535 in molten LiNaKF salt

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Abstract Ni-based alloy GH3535 is one of the best candidate structural materials for the molten salt reactors, and corrosion is one of the key degradation mechanisms for materials used in the reactor. The components of the reactor will be in direct contact with the flowing corrosive molten salt during its operation, therefore surface condition of the components will play a vital role in determining their early stage corrosion and degradation. In the present stage, machining processes, includes milling, turning, drilling and *etc*, are usually used as the final surface preparation method for the components of the reactors. However, the effects of the surface machining-induced microstructure change on the corrosion behavior of alloy GH3535 in the molten salt have not been investigated up to present.

In this study, the milling(a typical machining process)-induced microstructure and stress state changes and their influences on the corrosion behaviors of alloy GH3535 in molten FLiNaK salt have been investigated. GH3535 plates were milled with several representative parameters; topography of machined surfaces, elements distributions and microstructure of machining-induced deformation zones were investigated *via* complementary techniques before and after corrosion tests. The corrosion tests were performed in the static high temperature molten LiF–NaF–KF salt at 650 ^{o}C protected by high purity argon for different duration. The results show that a severely plastically deformed zone with gradient microstructure and residual stresses was introduced to the alloy during the milling process; the deformed zone consists a topmost nano-crystalline layer, a twining intersected layer and a slightly deformed layer near the substrate. Cr element dissolution, inter-granular corrosion and exfoliation of fine-grains occurred on the milled surface during the corrosion test, which lead to a faster corrosion rates of the milled surfaces than the polished surface. Cr elements dissolution lead to the formation of many nano- to micro- sized pores in the recrystallized fine grains and also change in the lattice parameter. Mechanisms of the formation of the deformation region on the alloy, and also mechanisms for the

enhanced corrosion in the machined surface were discussed based on microstructural features of deformed region as well the the elements dissolution.

Keywords Nickel-based alloy; Surface machining; Ultrafine-grained layer; Molten salt corrosion; High temperature corrosion.