Ordered and disordered corrosion morphologies on Ni-based alloy in the passive state

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Abstract Nickel-based single crystal superalloys are key materials for the superior performance of turbine blades in aeroengines. Their excellent mechanical properties such as superb high-temperature strength and toughness, superior creep strength, and good fatigue resistance are attributed to the unique dual-phase microstructure in which an ordered γ'(Ni_3Al) precipitated phases with $L1_2$ crystal structure are embedded in the γ matrix (Ni solid solution). However, whether the γ and γ' phases show similar passivation and dissolution characters has not been well explored, whereas this is crucial to the understanding of the performance of blade materials in humid environments. In this presentation, We report an order and disorder combined corrosion morphology of dual-phase Ni-based alloy in the passive state. After galvanostatic polarization in the passive region, the surface of the γ(Ni) phase presents amorphous feature while that of the γ'(Ni_3Al) phase maintains crystalline. The variations in weight percentages of Ni (50.19% → 3.80%), Co (19.24% → 0.65%), Ta (0.85% → 21.19%), and W (5.73% → 43.79%) of γ surface are evident, whereas the composition of γ' surface is nearly unchanged. The passive film comprises W_{ox}^{6+}, Ta_{ox}^{5+}, Cr_{ox}^{3+}, $Co_{ox}^{8/3+}$, Ni_{hy}^{2+}, and Co_{hy}^{2+}, and it shows stronger protection effect on the γ phase.

Keywords Ni-based alloy; passivation; microscopy; density functional theory

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