Corrosion and stress corrosion cracking resistances of the 17-4PH precipitation hardened martensitic stainless steel additively manufactured using binder jet printing

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Abstract By comparing the corrosion and stress corrosion cracking (SCC) properties of 17-4 PH martensitic stainless steel produced by the binder jet printing (BJP) and conventional manufacturing (CM), the effects of pore and microstructure changes caused by sintering and hot isostatic pressing (HIP) on them were studied. Through microscopic observation, BJP and HIP samples contain interstitial δ-ferrite and MnS inclusions, while CM samples do not contain above inclusions but NbC inclusions. The results of immersion, cyclic potentiodynamic polarization and galvanostatic (GL) tests show that the corrosion performance of BJP alloy is not as good as that of CM alloy. This is due to the high porosity of BJP alloy, but the NbC inclusion in CM also has an adverse effect on corrosion. In the SCC test, the CM sample fails quickly and has the lowest SCC resistance, while the BJP sample has high SCC resistance, which is due to the better corrosion resistance of δ-ferrite than that of martensite. The BJP sample treated by HIP not only reduces the porosity but also retains relatively high δ-ferrite, which makes its corrosion resistance and SCC resistance better than that of CM sample. These results demonstrate, emphatically, that the subtle microstructural variations in the additively manufactured (AM) alloys can have profound effects on their properties, especially those related to structural integrity and reliability.

Keywords Stainless steel; Corrosion; Stress-corrosion cracking; Ferrite; Additive Manufacturing.

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