Corrosion behavior of additively manufractured 316L stainless steel in Proton Exchange Membrane Fuel Cell environment : Effect of processing methods and heat treatment

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Abstract Additive manufacturing is a promising method to fabricate complex 316L stainless steel components, such as bipolar plates in proton exchange membrane fuel cell (PEMFC). However, corrosion is a critical issue limiting the utilization of 316L stainless steel in PEMFCs. This report compares the corrosion behavior of 316L steels manufactured by different processing methods, and found the corrosion resistance decreasing in the order: hybrid in-situ rolled wire-arc additive manufactured (HRAMed)> Selective laser melted (SLMed) > wrought steel. Furthermore,the heat treatment process of 316L steel produced by HRAM was further optimized to improve its corrosion resistance and mechanical properties. It was found that with the increase of annealing temperature (650 ~ 1200 °C), the corrosion resistance of HRAM 316L steel in PEMFC environment showed a complex change trend. Particularly, after annealing at 1050 °C, the steel exhibits excellent corrosion resistance and the annealing-induced abnormal strength-ductility synergy was observed. This was primarily attributed to the transition of δ-ferrite to σ phases, which not only promotes the formation and stability of passive film, but also inhibits the initiation and coalescence of cracks.

Keywords Additive manufacturing; 316L stainless steel; Corrosion behavior; PEMFC; Hybrid in-situ rolled wire-arc additive manufactured; Heat treatment; Microstructure.