Cold spray coating of AlCrCoFeNi high entropy alloy for corrosion protection of powder metal parts

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Abstract

Cold spray coating, also known as supersonic particle disposition, is a process that is applicable to corrosion resistance, dimensional restoration and wear resistance coatings. The unique ability to provide a corrosive resistant coating with convenience and environmental friendliness is the main attraction to cold spray coatings. In this study, a high entropy alloy with an equimolar composition of AlCoCrFeNi was cold sprayed on F-0008 powder metal part for surface modification and corrosion protection. The cold spray coating was performed at 600 °C in the air as well as in nitrogen atmosphere. To improve the surface coating, cold sprayed specimens were heat treated at 900 °C in argon atmosphere for 2 hrs. Corrosion testing was performed on as-sintered, cold-sprayed, and heat-treated specimens by exposing the specimens with salt-spray until corrosion state reaches ~ 50%, determined visually. Detailed characterization of the coating thickness, elemental analysis, and corrosion behavior of the specimens are reported in this paper.

Introduction

Corrosion, a leading cause of material degradation, represents a global challenge with an estimated economic impact of $2.5 trillion USD annually. Iron-based alloys like F-0008, frequently used in powder metallurgy (PM), are especially susceptible to corrosion. However, they are valued for their cost-effectiveness and mechanical strength. This study explores the potential of cold spray technology to improve the corrosion resistance of such alloys by applying a high entropy alloy (HEA) coating.

High entropy alloys (HEAs), particularly AlCrCoFeNi, have garnered significant attention due to their multicomponent nature, which offers versatile mechanical, thermal, and chemical properties. These alloys are increasingly being considered in corrosion protection applications because of their inherent resistance to various corrosive environments. Cold spray coating provides a unique advantage as it deposits particles at high velocity, allowing for bonding without significant thermal input, preserving the chemical composition of the substrate.

This report investigates how cold-sprayed HEA coatings, particularly AlCrCoFeNi, can enhance the corrosion resistance of F-0008 substrates, optimizing spray parameters, coating thickness, and heat treatment techniques.