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Influence of thermal treatment of novel NiAl coatings produced by in-flight Combustion Synthesis

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Abstract

In recent years, nickel aluminides have attracted considerable attention because of their great potential for high temperature protective applications, attributed to their high melting points, excellent resistance to environmental degradation and good mechanical and chemical stability at high temperatures.
This paper presents the interim results of a study to produce NiAl intermetallic coatings on stainless steel an adapted thermal spraying process wherein metallic Ni and Al powders react by combustion-synthesis to produce the intermetallic coatings in-flight during the spraying process and on the substrates. This became possible by adjustment and optimisation of the flame-spraying process parameters. We call the new process "Combustion-Aided Flame SpraYing" or "CAFSY" (Greek for combustion).
The grain size range of the Ni and Al powders used were 45-75μm and 5-100μm respectively and prior to spraying, the SS304 samples were sand-blasted to obtain a rough surface as normal procedure. During spraying, the Ni + Al powder mixtures are ignited by the combustion flame and react. Various NiAl intermetallic compounds are formed on the substrates due to exothermic reactions taking place in the flame in-flight over times of milliseconds.
The morphology and microstructure of the coatings produced were examined by scanning electron spectroscopy (SEM) and X-Ray Diffraction (XRD). Porosity, surface roughness, microhardness and adhesion of the coatings were measured. In addition, the coatings were tested for erosion and corrosion resistance.
The present work is part of a wider study aimed at developing the CAFSY method with particular emphasis on developing it as a low cost, rapid NiAl coating method for several applications.
The results of the investigations show that coating quality and performance is influenced by thermal spray distance, substrate temperature and flame temperature of the powder. Increasing thermal spray distance decreases NiAl, Ni_3Al and $NiAl_3$ intermetallic phases whereas increasing substrate temperature increases $NiAl_3$ and Ni_3Al phases and adhesion strength and decreases porosity and surface roughness. Finally, electrochemical testing of the CAFSY coatings in 3.5%NaCl indicates that they are very resistant to pitting corrosion. The work is continuing.

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