Microstructure and Mechanical Properties of Thermal Sprayed nanocrystalline Cr_3C_2 Coatings

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Introduction

Preparation of nanostructured feed stock powders is the first step for synthesis of nanostructured coatings. Of the various techniques available to produce nanostuctured materials mechanical milling enables large quantities of nanostructured materials to be produced. Nanocrystalline material for use as feed stock for producing nanostructured coatings by thermal spraying can be obtained by attritor milling. In this investigation attritor milling has been used to produce nanocrystalline powders of Cr_3C_2-NiCr as this powder system has been widely used to coat a variety of substrates to increase its wear and corrosion resistance. This powder system has been used to protect substrates in corrosive environments and at service temperatures up to 800-900ºC. Published data indicate that the hardness of these coatings decrease slightly at temperatures above 600º C.

This paper presents the effects of attritor milling medium and duration of milling on Cr_3C_2-NiCr powder characteristics. As received and nanaocrystalline Cr_3C_2-NiCr powders were then used to coat AISI 310 stainless steel substrates using HVOF spraying. The microstructures as well as the hardness of the coatings obtained with the two types of powders are also presented and compared.

Commercially available Cr_3C_2-20(Ni20Cr) powders were milled in a ZOZ attritor mill at 400 rpm and a ball to powder ratio of 10:1. The two milling media were hexane gaseous nitrogen. Milling was carried out for 1, 2, 4, 8 and 16 hours. X-ray diffraction analysis was used to determine the crystallite size and a Cilas laser equipment was used to determine particle size distribution in powders milled under the different conditions. X-ray fluorescence analysis was used to determine the composition of the as-received and milled powders. based on results obtained from these analyses milled powders with particle size appropriate for HVOF spraying was selected. The milled powders and the coatings were examined in a scanning electron microscopic coupled to an EDS analyzer.