Wear Characteristics of Ni-WC Powder Deposited by Using a Microwave Route on Mild Steel: Microwave Cladding of Ni-WC

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ABSTRACT

In the present research work, Ni-WC powder was deposited on mild steel using a microwave applicator. Deposited clad has a thickness of 0.5 mm and deposition time taken for coating was 15 minutes for each sample size. The developed layer on the substrate was analysed through several testing techniques include mechanical characterization by the Vickers hardness test and a wear test on the Pin-on-disc apparatus according to ASTM-G99 standard. Furthermore, micro structural characterization was done by using scanning electron microscopy technique and it has shown proper bonding between powder and substrate. Coating showed excellent results in terms of hardness and wear resistance as compared to base material mild steel. The pullout, scoring and abrasion were the responsible wear mechanisms in the substrate and clad.

KEYWORDS

Microhardness, Microwave Cladding, Ni-WC Powder, Wear Resistance

1. INTRODUCTION

Engineering applications include the components which are subjected to sliding and rubbing within the integral parts of the machinery and wear occurs due to this contact between machine elements (Hebbale & Srinate, 2016; Clark, Folz, & West, 2000; Gupta & Sharma, 2011). The failure of the components due to wear leads to economical loss and further immediate replacement of parts is required for the continuous working of the applications especially the production lines in industries. To prevent the material from degradation and downtimes of the production lines, coating process is being used by the researchers to enhance the surface properties of the material. The upsurge demand in the fabrication of materials has been observed as the components are subjected to some specific hostile conditions. The wear of materials is one of the major issues faced by the some typical engineering applications. The mechanical properties are responsible for combating the wear. Therefore, the microwave processing has been studied to know its mechanism and behavior of different materials.
processed using this technique, and improvement in the mechanical properties have been observed. The materials do not absorb microwaves at room temperature, but they start absorbing microwaves at high temperature. The heat from the microwaves can be utilized to fabricate the materials in the form of cladding, melting and joining. The microwave heating has various characteristics due to which it has become popular for heating low temperature applications as well as high temperature applications. The absorption of microwaves directly at the molecular level of coupled materials with the microwaves corresponds to volumetric heating of that material, which consequently leads to the rapid heating and reduced thermal gradient inside the materials being processed. The volumetric heating feature in microwave processing leads to high heating rate and this feature overcomes the limitation of conventional heating and consumes less processing time, which directly results in less energy consumption. An outstanding feature of selective heating in microwave processing is that microwaves directly impacts at the focused region, which interns helps to reduce heat affected zone up to an extent and reduces the defects simultaneously. The work carried out by several authors in this field reported huge amount of savings in processing time which corresponds to less power consumption during microwave processing of materials. These are some of the common characteristics with enhanced diffusion rates and improved properties. After having a tremendous achievements in field material processing through microwave ovens, this technology is being implemented at the industrial level for melting purposes through microwave furnaces. The techniques which have been used include Physical Vapour Technique (PVD), Chemical Vapour technique (CVD), Thermal Spray Coating (TSC) techniques and heat treatment (Gupta & Sharma, 2011; Thostenson & Chou, 1999; Singh & Sharma, 2016; Harsha & Dwivedi, 2007; Harsha, Dwivedi, & Agrawal, 2007). These processes provide good wear resistance against the severe fragile conditions and decrease the wear rates of the engineering components. The sputtering process like CVD and PVD are very costly and does not facilitate the mobility where a coating can easily be done at the location of components such as welding process. Moreover, these processes use gases for combustion process and therefore not eco-friendly to the environment hence produces pollution and eventually not safe. Recent advancements in the coating techniques come up with a technique known as Microwave Processing of materials with the use of domestic applicator. Microwave processing has several characteristics which are advantageous than other processes like the provision of selective heating, volumetric heating, pollution free and less processing time (Singh, Gupta, Jain, & Sharma, 2014). An outstanding feature of selective heating in microwave processing is that microwaves directly impacts at the focused region, which interns helps to reduce heat affected zone up to an extent and reduces the defects simultaneously. The work carried out by several authors in this field reported huge amount of savings in processing time which corresponds to less power consumption during microwave processing of materials (Zafar & Sharma, 2014; Preciado & Bohorquez, 2006; Vasudev, Thakur, Bansal, & Singh, 2017; Vasudev, Thakur, Bansal, Singh, & Zafar, 2019). These are some of the common characteristics with enhanced diffusion rates and improved properties. After having a tremendous achievements in field material processing through microwave ovens, this technology is being implemented at the industrial level for melting purposes even through the microwave furnaces. In this process material to be deposited is taken in powder form and deposited on the surface of the substrate in the microwave applicator through the heat produced by the microwaves and finally powder get melted and makes bonding with the parent material. This process does not use any gas for combustion and therefore pollution free and very economical as compared to other coating techniques (Vasudev, Thakur, Bansal, & Singh, 2018; Vasudev, Singh, Bansal, & Thakur, 2019; Kaushal, Gupta, & Bhowmick, 2017). Microwaves are not forms of heat, rather form of energy that is converted to heat energy through their interaction with the materials being irradiated. The interaction of microwaves with molecular dipoles results in rotation of the dipoles, and internal resistance offered by dipoles to rotation (due to oscillating electromagnetic field) is converted in to heat. They interact with material at the molecular levels and it is the dielectric properties of the material that describes the interaction of material with microwave. In dielectric materials, the local charge moves in response to an applied electric field (Sharma,
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