ULTRA HIGH MOLECULAR WEIGHT POLYETHYLENE COATINGS BY COLD SPRAY TECHNIQUE

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Abstract :

1. Introduction

The process known as cold spraying (CS) was developed in the 1980s by Dr. Papyrin and co-workers and involves the impact of metallic particles on to a target at very high speeds (500 to 1500 m/s) to form coatings or solid components [1]. The accelerating gas is heated to achieve higher particle velocities. Main idea behind this research work is the development of ultra high molecular weight polyethylene (UHMWPE) coatings with functional properties like wear resistance, impact resistance and cavitation erosion resistance.

2. Experimentation, discussion

Experiments conducted using a conventional low pressure cold spray apparatus yielded only a few number of UHMWPE particles depositing on Al substrate due to the lack of active surface creation upon impact. The nozzle length was increased to 200 mm from 100 mm. The increase in the length rendered an increase in the travel time for the polymeric particles with the carrier gas aiding a better and more uniform softening and plastic deformation of the particles. Gas temperature and pressure range of 350^{o}C-380^{o}C and 0.3-0.4 MPa respectively was found to be optimum spray condition which yielded a thin UHMWPE coating of 45 μm on Al substrate. The lack of build up in the coating was solved by addition of nano ceramic particles like nano alumina and fumed nano alumina addition to the feedstock. After a careful tuning of gas temperature and pressure, a 70 μm thick coating was obtained on Al and PP substrate when nano alumina was added to the feedstock. Similarly, a 4mm and 1mm thick coating was obtained on Al and PP respectively with fumed nano alumina addition. Nano ceramic particles played a very important role as a bridge bond between each grain of UHMWPE and between the UHMWPE particle and the substrate surface, which reinforced the particle-particle bonding, and particle-substrate bonding.

The Differential Scanning Calorimetry (DSC) reports of the rebound particles and deposited particles were different. The DSC curves of the rebound particles were observed to have the similar melting temperature and crystallinity as that of the nascent powder. On the other hand, the DSC curves for the deposited particles were observed to have a lower crystallinity and melting temperature than that of the nascent powder. The deposited particles were observed to be melted during the cold spray experiment, and after recrystallized during the cooling.

References :

[1] McCune, R. C., W. R. Donlon, E. L. Cartwright, A. N.Papyrin, E.F.Rybicki and J.R.Shadley. Proceedings of the 1996 National Thermal Spray Conference, (1996) 7-11.