INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING AND TECHNOLOGY (IJARET)

ISSN 0976 - 6480 (Print)
ISSN 0976 - 6499 (Online)
Volume 3, Issue 2, July-December (2012), pp. 275-279
© IAEME: www.iaeme.com/ijaret.asp
Journal Impact Factor (2012): 2.7078 (Calculated by GISI)
www.jifactor.com

IJARET
©IAEME

SUPERSONIC PARTICLE DEPOSITION AS POTENTIAL CORROSION TREATMENT METHOD FOR HELICOPTER PART IN MALAYSIA

O.Nooririnah[1,a*],A.Rohana[1,b], H.N.Nazrul [2,c] , M.Suhana[3,d]

[1]Department of Manufacturing Engineering Technology, Faculty of Engineering Technology, University Teknikal Malaysia Melaka, Hang Tuah Jaya,76100, Durian Tunggal, Melaka, Malaysia.

[2]Engineering Department, CTRM Aviation Sdn.Bhd, Composite Technology City, 75350, Batu Berendam Airport, Melaka.

[3]Faculty of Business Management, UiTM Johor Kampus Johor Bharu,Jln Heman,Kg.Aman,Larkin,80350 Johor Bharu,Malaysia.

[a] Nooririnah@utem.edu.my, [b]rohana_abdullah@utem.edu.my, [c]Nazrul.nawi@ctrmaviation.com, [d]suhan291@uitmjohor.edu.my

ABSTRACT

Aluminium types 7075,2024 and magnesium casting alloys are widely used in aircarft components, example Helicopter because of their inherent weight advantages over other metals but premature failure due to corrosion is one of the main challenges associated with this alloys, which affects the safety and readiness of aircraft. This paper is an outcome of project to address corrosion problem at Helicopter part using supersonic particle deposition as potential corrosion treatment method in Malaysia.Current practise of corrosion treatment by OEMs such as Sikorsky are using DOW-17 process or thermal spray coating. Disadvantage of DOW-17 process,it involve hazard material and Thermal spray coating issue of porosity and fatigue failure.The procedure focusing on particle deposition at supersonic level using material powder that suitable with substrate.Supersonic particle deposition using Aluminium coating will provide total solution for corrosion treatment for Aluminum airframe structure. There is no application yet of this coating technology in Malaysia and on top of that, coating at low temperatue that creates negligible heat affected zone and lead to excellent fatigue properties between deposited material and substrate, this will contribute to a big potential of SPD application in aircraft, automotive and tooling industry .

Keywords: supersonic particle deposition, Aluminum, pitting corrosion, Porosity, Sponson spar

INTRODUCTION

Cold Spray or Supersonic particle Deposition (SPD) is a coating technology was initially developed in the mid-1980s at the Institute for Theoretical and Applied Mechanics of the Siberian Division of the Russian Academy of Science in Novosibirsk [1]. Supersonic particle deposition (SPD) is a technology in which metal, composite or polymer powder particles in a supersonic jet of compressed gas impact a solid surface with sufficient energy to cause plastic deformation and bonding with the underlying material without the creation of heat affected zones which are typical of other deposition processes (plasma spray) and which are undesirable in many structural applications [2]. Bonding between substrate and deposit material is a result of high strain rate deformation and adiabatic shear instabilities at the bond interface[1].This project focus on supersonic particle deposition as potential method to treat pitting corrosion at Helicopter part in Malaysia. Term Pitting corrosion refer to forming cavities and oxidation products in small (localized) area of the affected components. The severity of pitting corrosion is determined by the susceptibility of the airframe material to pitting attack. Unprotected,active metals such as magnesium; are most susceptible [3]. Sikorsky Aircraft Corporation is a world leader in the design,manufacture and service of military and commercial helicopter. For OEMs such as Sikorsky,current method to provide corrosion protection to Aluminum or Magnesium airframe structure using DOW 17 process or Thermal spray technology [4]. DOW 17 process involved with Sodium dichromate containing hexavalent chromium,that very dangerous in case of skin contact,ingestion and over expose by inhalation may cause respiratory irritation.Severe over exposure can result in death[5] and this will address a problem with OSHA and on top of this, even with chromoted surface treatments, Al and Mg components suffer severe degradation in service**.** Issue with thermal spray coating are application of heat to the substrate, lead to development of porosity and internal stress that contribute to fatigue failure**.** Objective of this paper, to study potential of Supersonic Particle Deposition as corrosion treatment for helicopter part in Malaysia.

THEORITICAL OVERVIEW

Supersonic particle deposition (SPD) is a technology in which metal,a fine solid Aluminum powders particles generally 1-50µm in diameter are accelerated to velocities in a range between 500-1000m/s by entrainment in a supersonic jet of compressed gas metal powder particles to impact a solid surface. The SPD process utilizes Nitrogen or Helium as a carrier gas with pressures ranging between 5.5 bar to 17.2 bar (80 psi to 250 psi). The carrier gas is heated within the gun to temperatures up to about 600°C[5]. Compressed gas of an inlet pressure enters of an inlet pressure and flows through a converging / diverging DeLaval-type nozzle to attain a supersonic velocity. The solid powder particles are metered into the gas flow upstream of the converging section of the nozzle and accelerated by the rapidly expanding gas to achieve higher gas flow velocities in the nozzle, the compressed gas is often pre-heated. These droplets then impact in a substrate to give a high yield of a partially solid deposit of controlled shape. This deposit is cooled by the gas stream and solidification is completed at much slower rates than the initial cooling rates in spray. Particle bonding in SPD is due to high rate deformation of the particle, adiabatic shear instability and requires high particle velocity > Vcritical [1]. Advantages of Cold Spray technology are 1.Superior Corrosion protection coating particularly on steel, magnesium and Aluminum. 2. Reusable for reclamation of eroded surfaces and application of wear resistant coating, SPD enables the continuing reuse of the base material.3.Can be applied to recover damaged geometry without adversely affecting the substrate and this contribute to no distortion, heat affected zones or embrittlement,[2]. Based on SPD advantages, Potential applications of this technology for Aero structure parts are Corrosion resistant coating, dimensional restoration and tooling repair, wear resistant coating and build bulk structure material.

CASE STUDY

Sikorsky S61A-4,Nuri Helicopter currently use for Multipurpose transport, carrying troops & humanitarian aid. As update, 30 Nuri Helicoter S61A-4, is serviceable. Fitting sponson spar part is often the main structural member of the wing, running span wise at right angles to the fuselage. The spar carries flight loads and the weight of the wings while on the ground. Other structural and forming members such as ribs may be attached to the spar or spars, with stressed skin construction also sharing the loads where it is used[4]. Fitting sponson spar Nuri Helicopter is made from Aluminum 7075-T6 but premature failure due to corrosion is one of the main challenges associated with this alloys and the most common effect of corrosion on aluminum alloys is called pitting. It is first noticeable as a white or gray powdery deposit, similar to dust, which blotches the surface,[3] .When the deposit is cleaned away, tiny pits or holes can be seen in the surface. Pitting corrosion may also occur in other types of metal alloys.For Aluminium airframe corrosion treatment, Particle size of the Al powder will be range between -45 to +5µm with deposition efficency up to 38% and porosity is less than 0.5%. Recommended Spray parameter are 250-325°C for temperature with pressure range between 100-250psi. Standoff distance is 10-25mm, feed rate is 12-15 grams perminute with gun traverse speed 40mm persecond for a 36-38mm coating perpass. Compressed nitrogen gas will be the carrier gas. Expected typical coating properties for Al corrosion treatment are minimum 3200 psi bonding stength and hardness range,HB 34-37. Based on SPD experiment that been conducted, Pitting problem at fitting sponson spar part is successfully treated using supersonic particle deposition technique.

Figure 1: Pitting corrosion of Fitting sponson spar AFT, Nuri Helicopter

CONCLUSION

Corrosion treatment for aircraft part is never been conducted in Malaysia and Supersonic particle deposition,SPD as potential corrosion treatment is still mainly in research stage but Deposited Aluminium powder with particle size range between -45 to +5µm using Supersonic Particle deposition technique to overcome pitting corrosion fitting sponson spar,AFT Nuri Helicopter was successful. A lot of study must be conducted in term of structural integrity for airframe part that already undergo SPD process; to confirm it serviceable status.

ACKNOWLEDGEMENTS

This work collaboration CTRM Aviation Sdn.Bhd,Malaysia with University Technical Malaysia Malacca, (UTeM).

REFERENCES

Journal paper

[1] M.Grujicic, Z.L.Zhao, W.S. deRosset, D.Helfritch, Adiabatic Shear Instability based Mechanism for Particle/substrate bonding in the cold-gas dynamic-spray process, Materials & Design 25, (2004) pp. 681-688.

Others

[2] O.Nooririnah, H.N.Nazrul, Supersonic Particle Deposition Corporate slide presentation, CTRM Aviation Sdn.Bhd and Manufacturing Engineering Technology, Faculty Engineering Technology, University Technical Malaysia Malacca, UTeM. (2012)

Handbook

[3] Korb.J.Lawrence, Olson.L.David, Davis.R.Joseph, Destefani.D.James,Corrosion in the Aircraft Industry, ASM Metal Handbook, Volume 13, 1024.

[4] S.Bruce, *Supersonic Particle Deposition Technology for Repair of Magnesium Aircraft Components*, Army Research Lab, (2006).

[5] Material Safety Data Sheet, Sodium Dischromate

[6] D.F. Brian, E.Tim, P.John, Application of Aluminium Coatings for the Corrosion Protection of Magnesium by Cold Spray, US army Research Laboratory,(2007).

[7] Papyrin A., Kosarev V., Klinkov KV, Alkimov A., and Fomin V, *Cold Spray Technology*, Elsevier, Oxford, (2007)

[8] R. Jones., N. Matthews., C.A.Rodopoulos., K. Cairns., S. Pitt, *On the use of supersonic particle deposition to restore the structural integrity of damaged aircraft structures*, International Journal of Fatigue,Vol 33, (2011), pp 1257-1267

[9] V.Julio, Z.Wenyue, Corrosion protection of Magnesium alloys by Cold Spray, Centerline, Canada, (2006).

[10] www.supersonicspray.com