Recent Trends in Detonation Spray Coating-A Review

Chamkaur Singh¹, Chandan Deep Singh² & Baljit Singh³

¹M.Tech., Mechanical Engineering, Punjabi University Campus, Patiala,(India)
²Assistant Professor, Department of Mechanical Engineering, Punjabi University,Patiala,(India)
³Assistant Professor, Department of Mechanical Engineering, D.B F.G.I, Moga, Punjab,( India)

ABSTRACT
When one or two component come in contact through mechanical action wear occur on both surfaces. Wear is an
common phenomena in most plant and machinery and is often a slow and progressive process. As the rate of wear is high
so it require frequent repair and replacement. Due to wear the dimensions of the product changes. Now a days’ surface
coating is applied to a great extent to improve the surface characteristics of material and to reduce wear. Detonation
spray coating represents cost effective and important technique for modifying the surface properties of engineering
components with a view to enhancing their performance and durability. Detonation spray coating increasingly being
used to improve the performance of engineering component including gear, bearing and metal cutting tool due to their
high hardness and mechanical structural properties .In the present research study efforts will be made to reduce the
wear resistance of leaf spring used in heavy and light automobile vehicles by surface modifications technique. Coating
were prepared on different grades of cast iron. These coating samples were investigated on pin on disk test at 1m/s and
subjected to pressure of 30N,40N,50N. These samples were weighed before and after pin on disc test. The results
obtained from coating were compared with uncoating samples.

Keywords: Wear, Detonation Spray, leaf spring

INTRODUCTION
To optimize the mechanical and thermal stresses of leaf spring in trucks depends upon a combination of
properties. It should be able to absorb thermal fatigue and should dissipate and absorb as soon as possible
while heat generated during leaf spring friction.

WEAR
Wear occur between two surfaces when they are in contact. Main factors to occur wear is friction. The
dimensions of the component changes when wear results. It may require replacement when small amount of
material has been removed. The removal of material during wear is slow process but very continuous and
steady. Wear is an common occurrence in most plant and machinery and is often a slow and progressive
process. If the rate of wear is high so it require frequent repair and replacement. Various types of wear are (1)
Abrasive wear (2) adhesive wear (3) erosive wear (4) fretting wear (5) surface fatigue and (6) Delamination.
To reduce wear and to increase performance and durability thermal spray coating is an important technique
where detonation spray gun is used having very dense microstructure. With detonation spray coating almost
every material can be coated and sprayed.

THERMAL SPRAYING
Thermal spray coating is an effective and low cost technique to change surface properties of component by
applying thick coating. In thermal spraying feed stock material like powder or wire when they are fully or
partially melted and accelerated into gas steam are feed into heat source spray equipment. To form a
continuous coating softened or molten droplet are impinged into substrate material. Thermal coating are
mainly used in application of such as automotive system, power generation, Boiler equipments, Aircraft
engines, Chemical process equipment, fan and compressor blade, combustion chamber, orthopedics and
dental, land-based and marine turbines, ships. By using coating technique and coating material different
functions of coating such as wear and corrosive resistance, electrical or thermal insulation can be achieved.
Thermal spray coating gives good adhesive strength, low porosity and surface coating with compressive residual stresses. It has been considered to deposit the coating such as

1. Flame spraying with powder or wire
2. Plasma spraying
3. Spray and fuse
4. Electric arc wire spraying
5. Detonation gun
6. High velocity oxyfuel (HVOF) spraying

DETONATION SPRAY

Detonation spray process in which measured quantity of combustion mixture consisting of oxygen and acetylene is fed through a tubular barrel (round vessel) closed at one end. In order to prevent back firing a nitrogen gas is allowed to cover the gas inlet. Fixed quantity of coating powder side by side is given as input into the tube. The gas mixture is ignited by simple spark plug inside the combustion chamber.

![Figure 1: Schematic Diagram of the Detonation Thermal Spray Process](image)

The gas mixture inside the chamber produces the high pressure shock waves, that ignites then propagate through gas stream, depending upon the ratio of combustion gases can go up to 4000 Deg C and shock wave velocity can reach 3500m/sec. The hot gas mixture inside the combustion chamber travel down the barrel at a high velocity and heat the particle to a plasticizing stage (only skin melting of particle) and accelerate the particle at velocity of 1200 m/sec. The hot gases produced in the detonation chamber travel down the barrel and impact the component to form a coating. Depending upon the type of coating material and coating thickness the detonation spray cycle can be repeated at rate of 1-10 shots per second. The combustion chamber at last finally is flushed with nitrogen to remove remaining hot particles from the combustion chamber.

SAMPLE PREPARATION

Small cylindrical pins with circular cross section diameter equal to 8 mm and length equal to 30 mm were prepared from GIHC grey iron. End faces of pins were grinded using sand paper of different grades 220,400,600,800,1000. Grinding was followed by polishing with different grades 1/0, 2/0,3/0,4/0 polishing papers. After detonation spray coating on grey cast iron using coating material. Pin on disk test were investigated.
LITERATURE REVIEW

Murthy et al.[1] Studied that WC-10-4CR has better abrasive wear resistance as compared to Cr$_3$C$_2$–20(NiCr) coating possibly due to high velocity oxy-fuel (HVOF) and detonation spray (DS) is used to increase wear resistance. WC-10-4CR and Cr$_3$C$_2$–20 (NiCr) coating are deposited by HVOF and pulsed DS process its low stress wear resistance coating are compared. The abrasive test were carried out using the three body solid particle rubber wheel tests rig by making use of silica grits as abrasive medium. The results specify that Detonation spray coating works better than HVOF coating due to its higher stresses induced by former process.

Kumar et al. [2] Studied the results in the field of synthesis and characterization Carbon Nano Tubes (CNT) reinforced nano composite coating by thermal spray coating the performance can be achieved by proper spraying thermal nano composite coating . Proper nano composite ceramic coating provide properties such as wear resistant and thermal barrier coating . Study shows that nano composite coating can successfully examined by using thermal spray coating.

Gobind et al.[3] Made an attempt to reduce wear in Braking Disc Rotor by using grey cast iron GI250 coated by WC-12CO and satellite-6 coating by detonation spray process. Before coating samples are examined on pin-on-disc test. Pressure is applied to 1m/s rotating disc at 40N,50N, 60N. Samples are measured before and after test with other coating samples. The result shows that WC-12CO on GI250 grew cast iron shows better results than satellite-6 coating.

Singh et al.[4] Have investigates that WC-CO and Cr$_3$C$_2$-NiCr coating is done on the boiler tube by using liquid petroleum gas (LPG).The testing were done by using SEM/EAX, metallography and XRD technique. Main motive was to compare the microstructure, porosity, surface roughness and micro-hardness of HVOF sprayed WC-CO, coating deposited on boiler stalls. Coating was done to reduce the tube failure in power plant and to increase the life of component.

Singh et al.[5] Demonstrate the test to reduce wear between two solid component. A small cylindrical pins having diameter 8mm and length 30mm were casted with GI250 and GIHC. The faces of these two pins were ground by using sand paper of different grades 220, 400, 600, 800 , 1000. After that Al$_2$O$_3$-Cr$_2$O$_3$-TiO and Ni$_2$OCr were sprayed to the casted sample component by detonation spray coating. The wear test were performed on coating and non-coating substrate under the load of 30N, 40N, 50N with fixed sliding velocity of 1m/s. Results shows that Al$_2$O$_3$-Cr$_2$TiO coating shown minimum volume loss from that of other combination.

Singh et al. [6] Concluded that thermal spray coating has extremely good adhesive strength and, low porosity with having compressive residual stresses. Mixture containing oxygen and acetylene is fed through tubular barrel fixed at one end After that measured quantity of coating powder is fed into the combustion chamber with the help of spark plug gas mixture is burned inside it. Depending upon coating material and thickness spraying repeated at the rate upto 1-10 shots per second. This process is repeated until required thickness of deposit is prepared. According to Singh et al. more research is needed in field of using nano structured powder with detonation spraying. Little work has been done more work has been needed to reduce wear resistance by using nanostructured powder in detonation spray coating.

G. Cueva et al. [7] Studied that wear between two or more compact graphite iron is more than wear between Grey and ductile iron. Gray iron i.e One grade 250(GI250), one high carbon (GIHC),and alloyed with Ti(GI2550Ti) and a graphite iron. Pin on disc wear test were conducted a PLINT-TE6 machine where load is pneumatically applied. Mercedez-benz sprinter vans brake pads were used as pins having square base area of 144 mm$^2$ and these pins were finished with sand paper of grade 400. Surface of pins was finished by polishing 1um diameter paste were finished on pin rotor system. The test was conducted upto 20 hours by applying pressure of 0.7,2 and 4mpa. Results clearly shows that compact graphite iron reached higher friction forces with maximum temperature as well as more losses for that of three grey iron at any pressure applied.

G. sundararajan et al. [8] Evaluated that to increase the durability, performance and to reduce wear resistance thermal spray coating is significant to use . To reduce wear resistance hardness of coating material is evaluated. Coating powder are WC-CO (with having in the range of 8-15 wt%), Al$_2$O$_3$ and Al$_2$O$_3$-TiO$_2$ (with TiO$_2$ in the range of 10-40 W%). Detonation process parameter is considered lower than hardness that can be
expected on the basis of composition. Results also show if Micro hardness of coating can be increased, abrasive and sliding wear resistance of coating will certainly improve. From study it was evaluated that coating technique is limited and significant improvement in coating is mandatory for Better understanding in coating.

Gao-yang et al. [9] Synthesized the hardness of coating and porosity with the help of detonation spray coating. With the help of X-Ray diffraction technique Molybdenum Beride powder (MOB) were investigated. X-Ray diffraction technique was performed under the condition of CuKα Radiation. Coating powder were sprayed on low carbon steel substrate having 10 x10 area. From results it was clearly seen that presence of Metallic Molybdenum in the coating result from decomposition of MOB powder during thermal spray. MO, MOB, andMo2B differ from original powder having metallic coating composition with oxygen/acetylene ratio. The molybdenum phase increases having phase greater for the fine powder. The MO phase present in coating results in deboronization.

Bolelli et al. [10] concluded that plasma-sprayed oxide ceramic coating, Cr2O3, Al2O3, Al2O3-13%TiO2 have microstructure and micromechanical properties. Pin on disk test and dry-sand steel test were applied to check wear resistance of plasma-sprayed ceramic coating (Al2O3, Al2O3-13%TiO2, Cr2O3). These results were then correlated to microstructural and micromechanical characteristic (microhardness, fracture, toughness) and then correlated with well known plating and with HYOF sprayed cements. Pin on disk test has low wear loss due to low hardness is there Cr2O3 has better wear resistance and low friction coefficient. Where as Al2O3 and Al2O3-TiO2 coating possess high wear loss and friction coefficient. Further research is needed to improve the wear behavior by thermal sprayed Cr2O3.

H.Goto et al. [11] Conducted an test on unlubricated wear resistance for 0.35%C Steel on pin on disk machine in moist air step by step loading between low and high levels. Applying load on first stage wear between two surfaces formed by oxidization, work hardening and flatterting of contact surfaces under mild wear for long sliding distance which bring low specific wear rate. The upper critical load between severe and quasi-mild wear is quite greater than constant load resulting in improvement in wear resistance whereas in second stage warm surface is oxidized for low sliding distance at low load results in quasi-mild wear.

Coronado et al.[12] Determines the micro-hardness, elastic modulus and fracture toughness of white cast iron having 7.3% of Cr is casted into Copper chill plate to solidify it by using technique on transversal and longitudinal direction. The microstructure is mainly M7C3 and Led Barite Matrix using fixed alumina abrasive grains at load in between 2N and 15N. Pin axe and abrasive test were conducted by cutting the specimen into parallel and transversal direction. The M7C3 carbides show related value of fraction toughness when correlated with carbides in longitudinal direction. The result shows that load greater than 10N show higher abrasive resistance than longitudinal carbides. For identifying wear micro mechanism through scanning electron microscopy the surface wear was examined Results shows that cracks in M7C3 carbides produced from a narrow channel were monitored.

Branco et al. [13] Discussed the result to show that virgin PET has higher friction and wear rate related to coating. The wear resistance was conducted to check friction force and acoustic emission, light and scanning microscopy. Thermal spraying is checked to get better material coverage from corrosion and wear.

Singh et al.[14] Studied the wear resistance of braking disc rotor by surface modification technique based on wear properties of grade cast iron GIHC coated by WC-12CO and satellite-6 comparison is made in between these two by depositing detonation spay process. Small cylindrical pins of GIHC grade having diameter of cylindrical circular cross section equal to 8 mm length 30 mm were prepared for GIHC grey iron. End faces of pins were grinded using sand paper of different grades 220, 400, 600, 800, 1000. After detonation spray coating on grey cast iron using coating material WC-12CO and Stellite-6. Pin-on-disk test were conducted. The results show that WC-12CO on GIHC grey cast iron performs better than satellite-6 coating. WC-12CO-GIHC coating shows less wear loss.

Yilmaz et al. [15] Studied the plasma spray coating used mainly where high wear and corrosive resistance with thermal insulation is needed. Al2O3-TiO2 plasma spray coating is used. (Al2O3, 13 wt.%, TiO2, AlO2–40 wt.% TiO2 andAl2O3–50 wt.% TiO2) were prepared by using AISI 304L austenitic stainless steel substrate. The effects of TiO2 addition on the properties of the coating were evaluated in terms of microhardness and
fracture toughness value steel as substrate. With standard characterization technique the result obtained from the experiment work were evaluated. The results obtained describe that with increase in TiO$_2$ amount lowers the microhardness of coating and improves fracture toughness.

REFERENCES