RESEARCH ARTICLE

DOI: 10.34256/bsr1929

BULLETIN OF SCIENTIFIC RESEARCH

Selection of Wear Resistive Nan coating in En8 Steel

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Received: 27-09-2019
Accepted: 14-11-2019

Abstract: Where is the abrasive or gradual removal of materials at solid surfaces? It is caused due to the interaction between the sliding surface by mechanical action. The abrasive wears can be recognised as scratches or grooves. To enhance the wear resistance suitable nanocoating is applied on the material surface for better tribological properties such as hardness and toughness. Wear resistant nanocoating is used to reduce or eradicate wear to extend the lifetime of the EN8 steel. EN8 is unalloyed medium carbon steel with better mechanical properties than mild steel and also readily machinable in any condition. The nanocoating materials such as Al2O3, TiO2, SiC, ZrO2, WS2, Si3N4 etc., are used to reduce wear and to enhance hardness and toughness on mild steel through various nanocoating techniques. This paper deals with selection of suitable nanocoating material through AHP (Analytical hierarchal process) - a multi-criteria decision-making method.

Keywords: Wear, Nanocoating, EN8 steel, AHP.

1. Introduction

Endless requirement for high productivity, lower energy consumption, better efficiency and reliability of machine components dictate continuous research on new wear resistant material. These materials should be high surface hardness and also have to be tough.

To enhance the wear properties of existing EN8 steel material, the alternate metals are addressed by few researches. Hence there is literature survey focused on identifying suitable advanced technique and materials to reduce the wear of EN8.

2. Literature Study

2.1 Advanced material

Nano technology is known as field of research since last century. Various nano scale level materials are produced using nano technology. Advanced materials are the nano materials having sizes ranges from 1-100 nm. The nano materials exist in different types based on their properties, size and their shapes [1]. Due to large surface area of nanoparticles the structural modification is easier [2]. Advanced materials results good

mechanical, physical and chemical properties hence advanced materials are used in much application. Nano composite material is combination of two or more different substrate of nano sized particles in order to enhance the specific properties due to different combined nano sized particles [3].

2.2 Nano coating

Nano coating is nanotechnology-based coating with very fine, thin layers of nano particles that are used to impart specific physical, and chemical to a substrate surface. Nano composite coating has been considered as protective coating for industrial field which is due to excellence in tribological properties as compared with traditional coating method [4-7]. In general wear in machineries is due to friction of the sliding in machinery parts with each other. The friction results in loss of machine efficiency and material wear leads to performance decrease [8]. Therefore, to decrease the wear and increase the hardness various nano coating techniques are performed.

2.3 Coating Technique

Coating techniques are preferred solutions for improving the surface properties [9-10]. The advantage of performing wear and corrosion tests of the coatings is to understand the behaviour of materials under tribological applications and corrosive environments [11].

2.3.1 Cold Spray Method

Cold spraying is performed at low temperature than melting point of sprayed material. Sprayed material has low porosity and low oxygen level. Cold spray method has high and adhesion. Matrix material like Cu, Al, Co, alloy and nano fillers such as nitrite, carbide, boride, diamond etc., are used for nano coating in cold spray method [12-19].

2.3.2 Thermal spray method

The matrix of metal or alloy is used to produce nano composite coating using thermal spray method. The alloy powder is nano sized produced by ball milling process [20]. The nano powder is dispersed in suspension solution using thermally sprayed and suspension plasma spray process [21-22] to perform thermal spray method.

2.3.3 Electroless deposition method

Nickel matrix and nano fillers used in cold spray method can also be used as nano fillers in eletroless deposition method. This method is used to improve hardness, anti-corrosion and anti-wear by thermal post treatment ranging from 500-700ºC [23]

2.3.4 Electro deposition method

This method is used for the fabrication of nano coatings which contain organic Nano fillers and in organic nano fillers. Electro chemical co deposition of oxides and metal nano particles are carried out through this method. Electro deposition method is cost efficient and easy manufacturing; hence this method is preferred [24]. The advantage of this method is uniform distribution of nano particles, reduction of waste materials [25], and high hardness heat resistance due to nano particles [26]. Few nano composite materials like Al2O3, TiO2, SiC [27-35] Ni-WC [36] etc., are coated using this method. Pulse current deposition method is a type of electro deposition method through which tribological properties are enhanced [37].

Although different types of coating techniques are available but electro deposition method are chosen because of non-thermal conductivity, technically feasible and

economically better technique to produce proper coating [38].

2.4 EN8 characteristics

EN8 is unalloyed medium carbon steel with better mechanical properties than mild steel and also readily machinable in any condition.EN8 steel grade belongs to the standard of BS 970-1955. Due to low alloy content it is used for different application for manufacturing of machinery parts like shafts in transmission systems, moderate surface hardness are required where the components are exposed to high stress. The wear resistant properties of EN8 can be enhanced by induction process. For these reasons, EN8 steel has been chosen as the suitable material for manufacturing of wear ring.

Table.1 Composition of EN8

Carbon	C	0.35-0.44%
Phosporous	P	0.05%
Manganese	Mn	0.60-1.00%
Sulphur	S	0.005%
Silicon	Si	0.10-0.40%

2.5 Suitable nano coating material for EN8

Few nano particles like Al2O3, TiO2, SiC, ZrO2, WS2, Si3N4 improve tribological properties through electro deposition method [39-52]. Nickel nano composite coating was reported as suitable material due to good corrosion resistance [36]. Tungsten carbide high thermal and wears resistance and also good dispersion properties. I-WC coating on EN8 material through pulsed current electro deposition process shows better tribological properties [36]. Ni-P-Al2O3 nanocomposite coating showed higher hardness and wear resistance compared with plane Ni-P, this coating technique was developed by electroless technique [11]. Tungsten material in nano coating technique influenced better mechanical and chemical properties like hardness, high corrosion resistance at high temperature. [53]

Ni-W coating containing nano sized Al2O3 was prepared under pulse plating procedure resulted in improvement of wear resistance. [53]

4. ASTM Standards for characterisation study of samples

The hardness, yield stress, impact and yield stress is already examined by few researchers. Hence with the examined mechanical properties it is decided that EN8 steel is low carbon mild steel with ASTM standard as ASTM E-384

Table-2 Mechanical properties of EN8

Max Stress	700-850 N/mm^2
Yield Stress	465 N/mm^2
Impact	28 J
Hardness	201-255 BHN

Sample testing

The heat specimen here subjected to hardness and tensile test to determine the mechanical properties like yield strength ultimate tensile strength and hardness properties of EN 8with and without coating.

3. Selection of Material Using Ahp Method

AHP is a multi-criteria decision-making method. It was developed by prof. Thomas. L. Saaty to solve complex problems in decision making. Input data can be taken from the actual measurement like cost, weight, and other mechanical properties of the material and also from the opinion of the user. Due to

the availability the input data, most of the researchers prefers to use this method. In this method the decision are taken based upon the ratios which are derived from the paired comparisons on different parameters. The input data provided by humans are not accurate so, there is a chance of inconsistency in this method.

The criteria planned for our AHP process includes

- Wear
- Hardness
- Tensile stress
- Compressive stress

EVALUATION OF CHOICES:					
	wear	cost	tensile	compression	Hardness
al203	5.00	6.00	665.00	5,500.00	22,050.00
Tio2	5.00	5.00	367.50	5,675.00	10,290.00
SiC	0.00	4.00	1,625.00	1,395.00	3,800.00
ZrO2	5.00	3.00	711.00	5,200.00	15,750.00
SiO2	4.00	7.00	155.00	1,800.00	9,500.00
WC	5.00	2.00	530.00	6,833.00	2,000.00
VO2	4.00	1.00	595.00	530.00	36,000.00
sum	28.00	28.00	4,648.50	26,933.00	99,390.00

Figure 1. Evaluation of suitable nanopowder for nano coating

	SCORES:	
al203	0.204	Highest is recommended
Tio2	0.166	
SiC	0.098	
ZrO2	0.138	
SiO2	0.185	
WC	0.102	
VO2	0.108	
checksum	1.000	

Figure 2. Selection of suitable nanopowder

From the Analytical hierarchal process method the obtained nano powder is Al_2O_3 which has anti abrasive property and less cost. Secondly the suitable nano powder for EN8 material is SiO_2 after the aluminium oxide

4. Conclusion

To enhance the tribological properties of EN8 material, suitable nano coating technique is preceded from AHP method. Further with the suitable nano material obtained EN8 is coated and the mechanical testing like tensile, compressive, wear, hardness and corrosion test is carried out for better hardness and anti-abrasive property.

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