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"A REVIEW ON INFLUENCE OF NANO PARTICLES ON THE WEAR BEHAVIOUR OF EPOXY RESIN POWDER COATINGS"

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Abstract

Growth in Nano composite coatings technology is implementing Nano composites coatings in different sectors of the industrial due to their excellent capabilities. Nano composite coatings offer numerous advantages; include adhesive strength, surfaced hardness, high temperature and corrosion resistances, the enhanced the tribological properties, etc. In addition of Nano-composite coatings are often applied in thin and smooth thickness, which allowed strength in equipment design, lower fuel economy, improved efficiency, lower carbon footprints, and therefore the low maintenance and operating cost. Nano composite coatings are utilize proficiently to scale back effects of corrosive situation. A Nano coatings may be a coating that whichever has parts within the Nano scale, or consists of layer that are but 100nm. The fine size of nanomaterial and therefore the high density of the powdered boundaries allow good adhesion and a excellent physical attention of the coated surface. This paper reviews the tribological behavior of Nano-composite coating on the surface of metal substrate. It summarizes the factor affected the corrosions of substrate also conditions where such as coating providing essential tribological properties.

1. Introduction

Coating is a thin coating applied to the surface of base material, also known as the substrate. Coating is basically applied for two reasons

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decorative or as a protective layer. It's deposited by many techniques such as Anodizing, powder coating, Thermal coating, Electro deposition. The curing also plays important roles in adhesion of the coating. After the curing of the coating the required properties are obtained which helps to increase the life of the substrate.

The spray guns through which the powder is sprayed creates an electrostatic charge on powder particles as they flow through the spray gun and on to the surface. The deposition of powder on the substrate can be controlled by the guns control it allows to change gun position velocity of deposition and the shape or pattern. Powder spray guns are operated manually and programmed i.e. fixed post, charging of the powder by internal or external source, creating a charges space in front of the spray gun by internal or external power source these have their advantages and disadvantages in coating.

2. Materials and methods

Table 1 give us a clear the picture of the nano-particles (NPs) applications consequently their wt., mediums and effects in friction and tribology. Some additives solutions enclose the suitable percentage of nano-particles have been used in the std oil. Properties of common thermosetting powder coatings are also shown in table 2.

Table 1. Different materials (NPs) and their effects.

Sr. No.	Name of NPs	Weight % and medium	Effects
1	Titanium oxides (TiO2)	0.1 - 1.6 weight % in water base mediums	Titanium oxide modified nanoparticles reduced the frictional force of pure wat
2	Copper (Cu)	Add 25nm TiO2 nano-particles into based oil with 0.01 weight %.	Improved wear resistance. Friction coefficient (COF) compared to when 0.01% by weight of pure oil based lubricant was used. COF

3	Copper (Cu)	Wear and friction behavior of Pegasus-1005 oil with copper additives as nano particles.	The observed 130 nm and Cu nanoparticles of motor oil were more effective than the motor oil itself containing 50 nm nanoparticles to reduce wear and friction.
4	Copper (Cu)	Blended Cu nano particles added into paraffin oil.	Results show that copper nanoparticles with a size of 2-5 nm reduce the COF of the steel pair and exhibit excellent thermal properties.
5	Alumina oxide (Al2O3)	Al2O3 nano particles with differents percentages in engine oil used to estimate their tribology.	The test results showed that the lowest coefficient of friction was obtained with an average nanoparticle size of 0.8 wt%.

Table 2. Properties of common thermosetting powder coatings.

Sr. no	Property	Epoxy	Hybrid	Hybrid Urethane	Hybrid TGIC	Acrylic
1	Application thickness mil (mm)	1-20 (0.025-0.508)	1-10 (0.025-0.254)	1-3.5 (0.025-0.089)	1-10 (0.025-0.254)	1-3 (0.025-0.076)
2	Cure cycle ° F (° C)	450 (232) 10 min	450 (232) 10 min	400 (204) 10 min	400 (204) 10 min	400 (204) 10 min
3	Metal temperature ° F (° C)	350 (177) 25 min	250 (121) 25 min	320 (160) 25 min	300 (149) 25 min	350 (177) 25 min
4	Pencil hardness	HB-7H	H-2H	HB-3H	HB-6H	2H-3H
5	Direct impact resistance lbf/in. (Nm)	60-160 (6.8-18.1)	80-160 (9.0-18.1)	60-160 (6.8-18.1)	60-160 (6.8-18.1)	20-140 (2.3-15.8)
6	Adhesion	Excellent	Excellent	Excellent	Excellent	Excellent

7	Chemical Resistance	Excellent	Good/Very good	Good/Very good	Good/Very good	Good
8	Mandrel bend	Excellent	Excellent	Excellent	Excellent	Poor
9	Salt spray resistance (hr)	1,000	1,000	1,000	1,000	1,000
10	Application ease	Very good	Excellent	Very good	Excellent	Good
11	Corrosion resistance	Excellent	Very good	Good	Very good	Very good

3. Literature survey

Title, Name and Year	Input Parameter and Powder type	Response Parameter	Composite material	substrate	Remark
Optimisation of wear parameters on Ni-Al2O3 nano-composite coatings by electro deposition process C. Raghavendra SN Applied Sciences-2019	Load, Hertzian pressure, sliding speed and distance Ni Powder	Wear rate	Ni-Al2O3	mild steel	Due to the presence of Al2O3 nanoparticles, the wear rate is lower than that of Ni plating. The normal load applied to the pin has a major effect on wear rate, followed by slide distance and slide speed, with a particular wear rate being the lowest at low loads.
Effects on the wear resistance nano-particles added to the powder polyester coatings through the ball milling Marı´a Ferna J. Coat Tech. Res-2018	Current, Gas flow rate, Electrode gap, Welding speed polyester powder	Wear rate	Silica nanoparticles	Al 7075	Added of nano-particles to consistency polyester alters the morphology structure of final coatings on substrate, and the amount of toughening agent added to The designated silica nanoparticles powder polyester reduces the weight loss of the organic coating in wear test. If you reduce it, voids tend to appear.

Hindering the decreas wear resistance of UVexposed epoxy powders coating by addiion Nano-SiO2 through ball milling M. Fern´andez Elsevier-2019	Frequency, load and temperature Epoxy powder	Wear and hardness	Nanosilica SiO2	Stainless steel	It is possible to delay the wear resist deterioration of the functionalized coating after UV- irradiation
Effect of Al2O3 reinforcemen t nanoparticls on the tribological behaviour of Al6061 alloy Huda A. Al-Salihi AIMS -2020	Speed, Load and reinforcement	COF and Wear	Al2O3	AA6061 alloy	The physical properties (tensile strength and hardness) of nanocomposites increased with increasing amounts of Al2O3 nanoparticles in the Al6061 matrix. The added of Si-O2 nanoparticle to the powdered polyamide accelerates the curing and curing of the resulting coating, with a slight decrease in crystallinity.
Manufacturi ng and Characterest ics of Coating from Polyamide Powder Functionaliz ed with Nano silica Maria Fernández MDPI-2020	Load, temperature Polyamide powder	hardness	Nanosilica	Mild steel	It has the least damage of crystallinity. That material shows the highest wear resistance after irradiation

4. Conclusion

Epoxy based composites have used in automobile, civil, aerospace, naval, electronic industries and wind energy due to their attractive and protective

properties. Many researchers have been done since the last few decades on epoxy composites.

Improve the demand for tribological properties of different mechanical systems, new designs and surface improvements and improvements in manufacturing technology. But there is Very little research on epoxy resin powder coatings and its effect of Nano fillers adding to them the epoxy resin powder coatings have an advantage over other epoxy based coatings since of easy to deposit and no initial processing of powder is required before apply on substrates. The use of Taguchi optimisation to improvement the wear properties is not enough in the literature revie. The use of nanoparticles for the wear resistance has been mentioned in may but the required optimum quantity of nanoparticles and the various parameters which will required to obtain the optimum value of the nanoparticles content is not studied. So to optimize the wear resistance and the hardness of the coating nanoparticle is used in different quantity.

It was found that the optimization can be done in process and in the coating material content. The material is reinforced with various Nano fillers and the wear is checked on pin on disk or liner reciprocating wear machine. The parameters to be considered during testing were%. w.t. reinforcement, Load, Distance/temperature, time are the main factors which determine the wear rate. Hence the optimization is done with taking the above parameters and keeping time constant.

5. Future Study

The epoxy powder coating can be used in extremely corrosive environment and where the thermal stability of coating is important to sustain the life if the coating. In thesis the wear property of the epoxy powders coatings is studied on mixing of nanoparticles with different content and further studies which can be conducted related to these coatings.

(1) Mixing of other nanoparticles to study the mechanical behavior of the coating and its characterization.

(2) Micro-structure of the coating can be studies to check the distribution of nanoparticles by SEM.

(3) Creating a hydrophobic surface over the coating.

(4) Comparison of Homogenous dispersion techniques for better mechanical properties (Solution method, melting method, hot mixing) for powder coating.

(5) Surface roughness of the nanoparticle coating.

(6) The work can be repeated by varying the weight percentage of the reinforcement.

References

[1] Naheed Saba is number one, recent achievements in epoxy resin natural fibre reinforced epoxy composite and their applications, Journal of Reinforced Plastics and Composites (2015), 1-24.

[2] I. Stojanovi, Experimental evaluation of polyester and epoxy polyester powder coating in harsh media, by I. Stojanovi. Coatings 8(3) (2018), 98.

[3] A. Ya. Grigorieva, et al., Friction and wear of powder coatings of epoxy composites with alumosilicate nanoparticles, ISSN 1068-3666, Journal of Friction and Wear, (2012), 101-107.

[4] M. H. Moradi, Corrosion and wear behaviour of SiAlON epoxy nanocomposite coatings, J. Appl. Polym. Sci. 133 (2016), 1-13.

[5] Xianming Shi, Effect of nanoparticles on epoxy coating anticorrosion and mechanical qualities, Surface and Coatings Technology 204 (2009), 237-245.

[6] Maria Fernandez Alvareza, Francisco Velascoa, Asuncion Bautistaa and Beatriz Galianab, Functionalizing organic powder coatings with nanoparticles through ball milling for wear applications, Applied Surface Science 513 (2020), 145834 doi.org/10.1016/j.apsusc.2020.145834.

[7] Mansour Rahsepar and Fatemeh Mohebbi, Enhancement of the wear resistance of epoxy coating in presence of MBT-loaded mesoporous silica nanocontainers, Tribology International 118 (2018), 148-156.

[8] S. Palraj and M. Selvaraj, Corrosion and wear resistance behavior of nano-silica epoxy composite coatings, Prog. Org. Coat. 81 (2015), 132-139,

[9] Sironmani Palraj, Muthiah Selvaraj, Kuppaianpoosari Maruthan and Gopalakrishnan Rajagopal, Corrosion and wear resistance behavior of nano-silica epoxy composite coatings, Progress in Organic Coatings 81 (2015), 132-139.

[10] Jingjing Yu, Wenjie Zhao, Yinghao Wu, Deliang Wang and Ruotao Feng, Tribological properties of epoxy composite coatings reinforced with functionalized C-BN and H-BN nanofillers, Applied Surface Science 434 (2018), 1311-1320.

[11] X. S. Xing, Wear behavior of epoxy matrix composite filled with uniform size sub-micron spherical silica particle, Wear 256(1-2) (2004), 21-26.