Nano Coat as an Effective Replacement for Bearing Liner

K.S.K. Mallik, K.V. Ramana

Abstract: This work highlights an experimental investigation on the surface roughness and hardness of a nano composite, which can replace the liner of a journal bearing. There is a possibility of rotation of bearing liner, due to inconsistent rotation of the journal about its geometrical axis. At the same time, the liner may have sliding action inside the bearing over a period of time. The said drawbacks can be eliminated by replacing the bearing liner by a nano coat. Babbitt is the most widely used material for bearing liner. The Tin of Babbitt alloy has been replaced by cadmium due to its low coat and better mechanical and thermal properties. The results show that, Cadmium is offering better surface roughness and hardness in comparison with the Babbitt.

Key words: Bearing liner, Babbitt, Cadmium, Mechanical Properties, Tin

I. INTRODUCTION

A bearing liner is the material which reduces the wear and frictional heat between the two contacting surfaces. Babbitt, an alloy invented by Isaac Babbitt in 1839 exhibitedsuperior bearing properties over other liner materials. The failure of liner can also be caused by a simultaneous and interrelated exhibition of fatigue and wear process that depend considerably on cohesive strength between the bush and the bearing and accumulation of defects on the contacting surfaces of the bush and the shaft. Good bearing design as observed by S.R. Hule et al. [1] includes three basic elements: understand the working atmosphere, designing for proper lubrication and selection of appropriate bearing material for the job. G. C. Pratt [2] reviewed the materials concerned sliding contact bearings which has its own peculiar property requirements. Nano powders production through a rolling-type planetary ball mill apparatus was disclosed by Chen S et al. [3]. Koring [4] in his work has presented a mechanism for improving the properties of bearing alloys and the environmental problems that has arisen.G.M. Xu et al. [5] have proposed $AlSn_8Pb_2Si_{2.5}Cu_{0.8}Cr_{0.2}$ as a bearing liner material with higher hardness, and the properties of bush material are greatly increased with uniform annealing at constant temperature. Kano et al. [6] have chosen normal temperature milling of differenttypes of powder materials based on their ability of griding. Z. Zongli et al. [7] in their work, considered the coatings of arc sprayed tin-based alloy. Mechanical properties of the coatings were tested, and an effective way to increase the tensile strength was mentioned.

The results indicated that coating has a satisfactory performance under the condition of rubbing, which is better than that of cast babbitt. S. C. Tjong [8] reviewed the manufacturing techniques and mechanical properties of the metal matrix composites reinforced with ceramic nanoparticles.

R. Casati and M. Vedani [9] reviewed the manufacturing methods used for the production of metal matrix Nanocomposites on large scale and the near future applications of the new class of composites. Hamdy A. S. [10] in his paper reported the research to develop environmental coatings and the problem aroused in designing high performance nano composite coatings. Tyona, M. D. et al. [11] reviewed the comprehensive theory of the spin coating technique. It highlights the fundamental principles and process parameters. K.S. K. Mallik and K. V. Ramana [12] carried out an experimentation to obtain nano particles through ball milling method and nano coating through spin coating technique and also tested the thermal properties of the nano coating[13-15].

II. EXPERIMENTAL METHODS

The basic metals of the suggested composite areAntimony, Copper, Lead and Cadmiumis obtained in micro size in acetate form.

A. Preparation of Nano particles

Ball milling method, in which a powder mixture is subjected to high energy collision to obtain nano particles [16-17], is performed on ball milling equipmentas shown in Figure. 1.

Fig 1 Insmart systems planetary ball milling equipment
The ball milling process specificationsare mentioned in table 1
Table 1: Ball milling process specifications

Ballpowder ratio	5:1
Speed	350 RPM
Diameter of the balls	6mm and 10mm
Weight of the balls	2 grams and 8grams
Material od balls and vials	Tungsten carbide
Time	Run time = 4 Min; Off time = 1 Min; No Of cycles = 12 Total Run time = (On time + Off time)*no of cycles = (4+1)*12 = 60 Min

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The time (in hrs) for gettingrequired size is 41, 52, 56, and 49 for antimony, copper, lead, and cadmium respectively. Through XRD and Scherrer equation the size of the powder is confirmed as 10nm. **BPreparation of Nano coating** The four different compositions of considered nano composite powderare presented in Table 2.

Table 2 Compositions considered

Composition	% of Cadmium	% of Lead	% of Antimony	% of copper
A	95	3	1	1
B	97	1	1	1
C	3	89	5	3
D	1	95	3	1

A solution of 1.0gram of proposed nano powder, 5.0ml of ethanol and 0.50mg of pvp is obtained through mechanical stirring. The solution is applied on mild steel substrate, drop by drop using spin coating equipment shown in Figure 2 for obtaining nano coating. The spin speed and spin time of spin coating are 1500 rpm and 30 sec respectively. After annealing, the coating thickness is tested under metallurgical microscope and the coating thickness on an average is 60microns.

Fig 2 Spin coating equipment

III. EXPERIMENTAL STUDY

A.HARDNESS

Universal hardness tester is used to test the hardness of the coatings by conducting the test at various points in three directions on the specimen and the Brinell's hardness number is calculated

B.SURFACE ROUGHNESS

The coated specimens are subjected to roughness test on TAYLOR HOBSON Surtronic S128 surface roughness testing equipment as given in Fig. 3 in different directions and the mean value is calculated.

Figure 3 TAYLOR HOBSON Surtronic S128 surface roughness tester

IV. RESULTS

The results acquired fromexperimentationare tabulated beside graphical representation.

A.HARDNESS

Surface hardness values are shown in Table 3

Table 3 Surface Hardness values

S.No	A	B	C	D
1	170	140	142	110
2	140	130	130	120
3	142	135	135	130
Mean	150	135	136	120
Babbitt alloy	30			

Figure.4 shows the variation between surface roughness and percentage composition
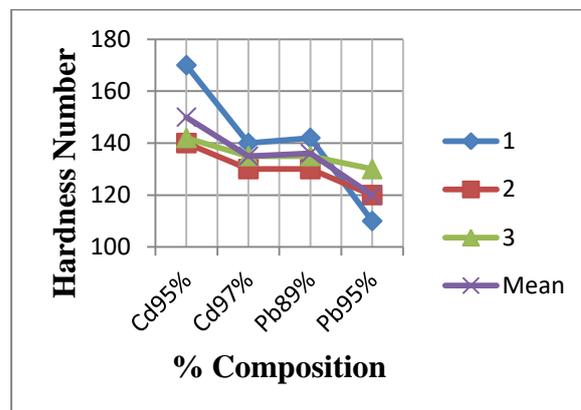

Figure 4: %composition vs Hardness number

B.Surface Roughness

Surface roughness values are shown in Table. 4

Table 4 Surface roughness values

S. No	A	B	C	D
1	0.75	1.5	2.2	2.4
2	0.85	1.5	2.0	2.0
3	0.75	1.8	1.9	2.2
Mean	0.78	1.6	2.03	2.2
Babbitt alloy	2.33			

Fig. 5 shows the variation between surface roughness and percentage composition
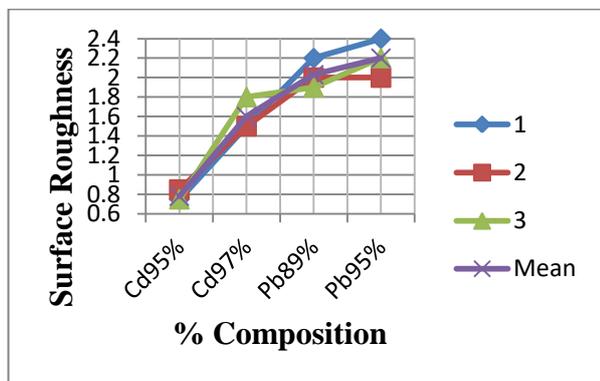
Figure.5 %Composition vs Surface roughness

V. CONCLUSIONS

1. Cd95% coating exhibits better surface roughness of 0.78 when compared to other coatings
2. The hardness of the sample Cd95%, 150 is higher than other coating samples

From the tested properties, it is clear that Cd95% is preferred over other coatings and also shows better properties when compared to Babbitt liner.

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