MEASUREMENT OF NON USED MICROBEARING GROOVED SURFACES FOR COMPUTER VENTILATOR XILENCE CASE FAN

Krzysztof Wierzcholski

Technical University of Koszalin
Institute of Mechatronics, Nanotechnology and Vacuum Technique
Śniadeckich Street 2, 75-453 Koszalin, Poland
tel.: +48 94 3478344, fax: +48 94 3426753
e-mail: krzysztof.wierzcholski@wp.pl

Andrzej Miszczak

Maritime University Gdynia, Faculty of Marine Engineering
Morska Street 81-87, 81-225 Gdynia, Poland
phone: +48 58 6901348, fax: +48 58 6901399
e-mail: miszczak@am.gdynia.pl

Andrei Khudoley

Luikov Heat and Mass Transfer Institute of National Academy of Sciences of Belarus
P.Brovki Street 15, 220072 Minsk, Belarus
tel.: +375 17 2841060, fax: +375 17 2841060
e-mail: khudoley@yahoo.com

Abstract

In this paper is presented the measurement analysis of two a new non-damaged cooperating microbearing surfaces occurring in computer ventilator Xilence Case Fan 92mm. Elaborated measurements concern Scanning Electron Microscope (SEM) images of journal and sleeve work surfaces, AFM roughness tests with 3D images of journal and sleeve work surfaces and profiles of their cross sections, Vickers micro-hardness value studies for journal and sleeve surface. Furthermore in researches of the sleeve surface are included measurements for macro-profile surfaces with herringbone grooves micro-profiles of small grooves utilizing and Atomic Force Microscope) AFM – NT-206 Belarus. The measurements are performed for a new non damaged journal and sleeve surface using the AFM and SEM & Micro-X-Ray analysis. Such analysis concerns results referring to the bearing material composition with standard deviation of measured values. The view of cylindrical microbearing journal surfaces with nano-ridges and grooves and measured non used and non damaged surfaces with longitudinal nano-ridges and grooves in cylindrical slide microbearing journal and sleeve; SEM image of work surface of the microbearing journal and microbearing sleeve of computer ventilator Xilence Case Fan, 3D AFM image of work surface of microbearing journal, profile of work surface of the journal, 3D AFM image of work surface of microbearing sleeve of computer ventilator, profile of work surface of the sleeve are presented in the paper.

Keywords: *computer ventilator Xilence Case Fan, microbearing, grooves, profiles of work surfaces*

1. Introduction

The flow of the lubricant in cylindrical micro-bearing gap is generated by the rotation of the journal with the angular velocity w and rotational speed 3000 rpm with oil viscosity 0.018 Pas [1]. A slide microbearing has been recently used in a computer ventilator replacing the conventional ball bearings, due to its outstanding low noise and vibration characteristics [2, 4]. In this application, herringbone grooves have the advantage of self-sealing which causes the lubricant to be pumped inward, and therefore, reduces side leakage. They also prevent whirl instability that is observed in the plain journal bearings at concentric operating conditions [1, 3].

Groove location has influence on the dynamic performances in computer ventilator microbearing Xilence Case Fan. Fig. 1 shows the microbearing with various grooves in journal and sleeve [3].

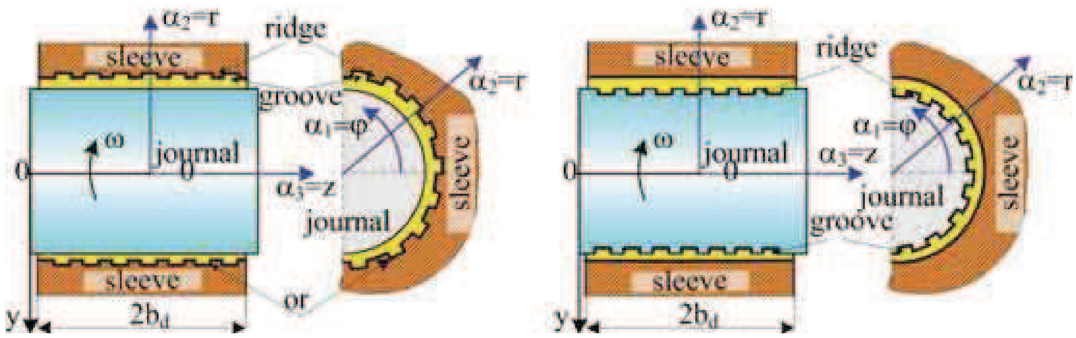


Fig. 1. The view of cylindrical microbearing journal surfaces with nano-ridges and grooves

Diameter of the journal has 3mm, radial clearance 3.15 μm, and microbearing has longitudinal grooves. Symmetric grooves of the journal micro-bearing generate the concentric motion of a rotor at the origin, but asymmetric grooves generate the concentric rotation with the eccentricity ratio of 0.2. Measured sample concerning journal and sleeve in a new non damaged microbearing surfaces is presented in Fig. 2.

Fig. 2. The view of measured non used and non damaged surfaces with longitudinal nano-ridges and grooves in cylindrical slide microbearing journal and sleeve, for computer ventilator Xilence Case Fan Flow

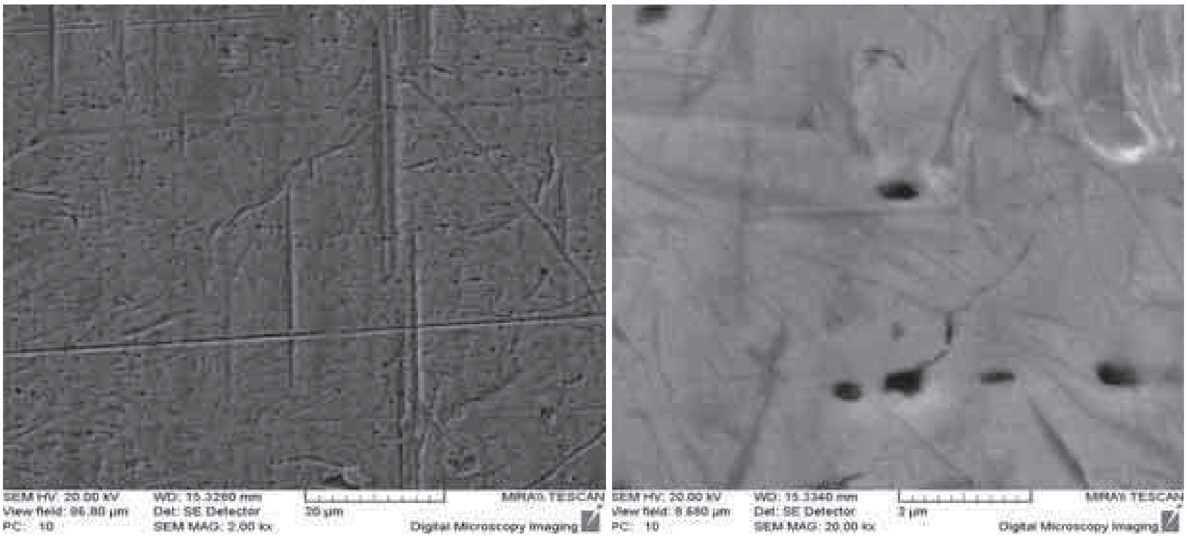
2. SEM & micro x-ray analysis of the journal work surface

The journal is made from Steel X20 Cr13 EN10250-4. Bearing material consists from following roots: silicon (Si), chromium (Cr), manganese (Mn), iron (Fe). Percentage values of mentioned ingredients are given in Tab. 1. The values are measured three times for three spectrums. The standard deviation values of measured results are calculated.

Tab. 1. X-Ray analysis results of percent values of ingredients occurring in journal bearing material

Ingredients	Si	Cr	Mn	Fe	Total
Spectrum 1	0.40	13.32	0.68	85.60	100.00
Spectrum 2	0.44	13.31	0.74	85.52	100.00
Spectrum 3	0.41	13.15	0.74	85.69	100.00
Average	0.42	13.26	0.72	85.60	100.00
Standard deviation	0.02	0.09	0.04	0.09	
Maximum value	0.44	13.32	0.74	85.69	
Minimum value	0.40	13.15	0.68	85.52	

Figure 3 illustrates the image of the journal work surface in two enlarged scales, using the Digital Microscopy Imaging. Fig. 3a presents the surface 86.80μm×86.80μm and enlargement picture showed in Fig. 3b describes the region ten times enlarged namely 8.680μm×8.680μm. In journal surface the grooves are not occurring. We can see only scratches from 1 to 2 μm wide.



a) b)

Fig. 3. SEM image of work surface of the microbearing journal in computer ventilator Xilence Case Fan: a) view field 86.80μm×86.80μm, b) view field: 8.680μm×8.680μm

3. SEM & micro x-ray analysis of the sleeve work surface

The sleeve is made from sintered metal –powder composition 80Fe-18Cu-2Sn. Alloy consists from following roots: iron (Fe), copper (Cu), tin (Sn). Percentage values of mentioned ingredients are given in Tab. 2. The values are measured only one time for one spectrum.

Figure 4 illustrates the image of the sleeve work surface in three successive enlarged scales, using the Digital Microscopy Imaging.

Figure 4a, Fig. 4b describe the regions 868.0μm×868.0μm and 173.6μm×173.6μm respectively. On the sleeve surface views presented in Fig. 4 the grooves are not arise. We can see only different phases of material and porosity of sintered composition.

Tab. 2. X-Ray analysis results of percent values of ingredients occurring in alloy on the sleeve work surface

Ingredients	Fe	Cu	Sn	Non identified	Total
Spectrum 1	77.92	17.71	1.89	2.48	100.00
Average	77.92	17.71	1.89	2.48	100.00
Standard deviation	0.00	0.00	0.00	0.00	
Maximum value	77.92	17.71	1.89		
Minimum value	77.92	17.71	1.89		

4. AFM roughness test for journal surface

Roughness of the journal working surface is measured in 3D space by the AFM in the view field 20700nm×20100nm×668.0nm for calculated average values Ra=62.8nm, and the values of root mean squares Rq=84.4nm. The results are presented in Fig. 5.

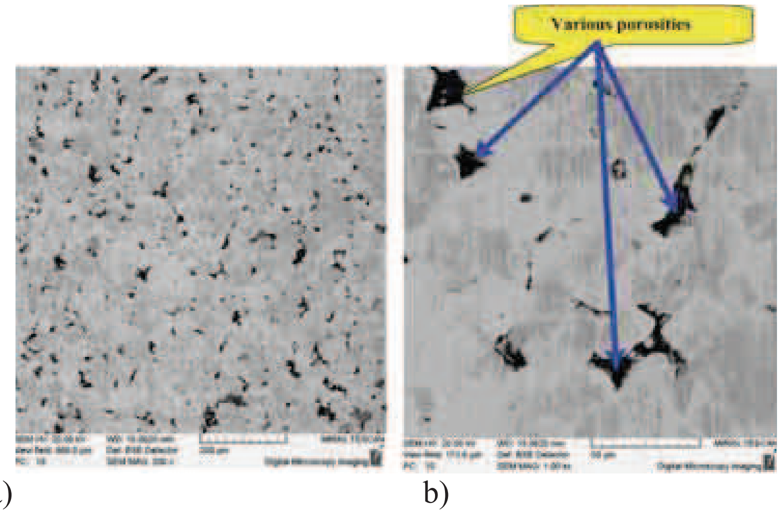


Fig. 4. SEM image of work surface of microbearing sleeve of computer ventilator Xilence Case Fan: a) view field 868.0μm×868.0μm, b) view field: 173.6μm×173.6μm

The cross section along the sample presented in Fig. 5 illustrates the height roughness and groove profile of the journal surface in Fig. 6.

Fig. 6 shows, that roughness of the journal working surface attain the height about 40 nm. The groove in the narrowest place attains about 250 nm wide and 500 nm deep.

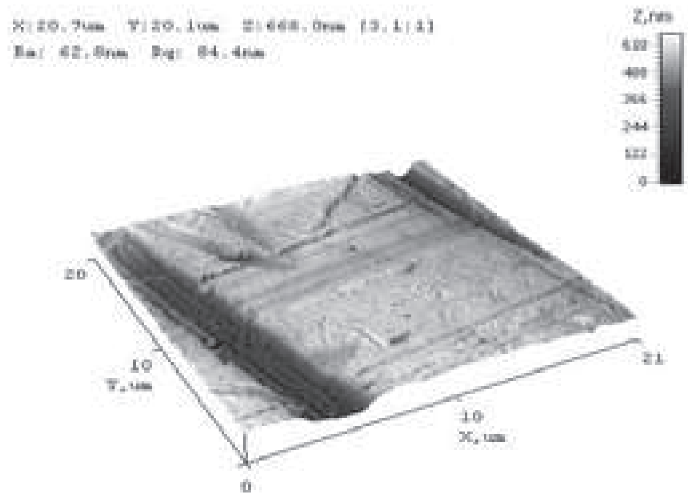


Fig. 5. 3D AFM image of work surface of microbearing journal of computer ventilator Xilence Case Fan: (Ra = 62.8 nm)

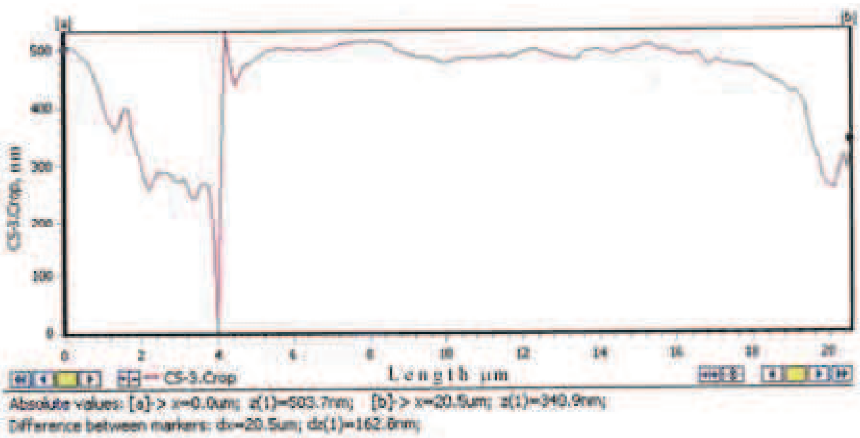


Fig. 6. Profile of work surface of the journal presenting roughness and groove height in nano-meters versus sample length in micrometers

5. Grooves measurements of sleeve surface

Roughness of the sleeve working surface is measured in 3D space by the Atomic Force Microscope in the view field 10 000nm×10 000nm×410.0nm for average roughness Ra=9.1nm, and for root mean square of roughness Rq=14.6nm. The results are presented in Fig. 7.
The cross section along the sample presented in Fig. 7 illustrates the height roughness and their profile of the journal surface in Fig. 8.

Figure 8 shows, that roughness of the sleeve working surface attain the height about 40 nm. One of the narrowest places of roughness attains value about 250 nm wide and 150 nm deep.

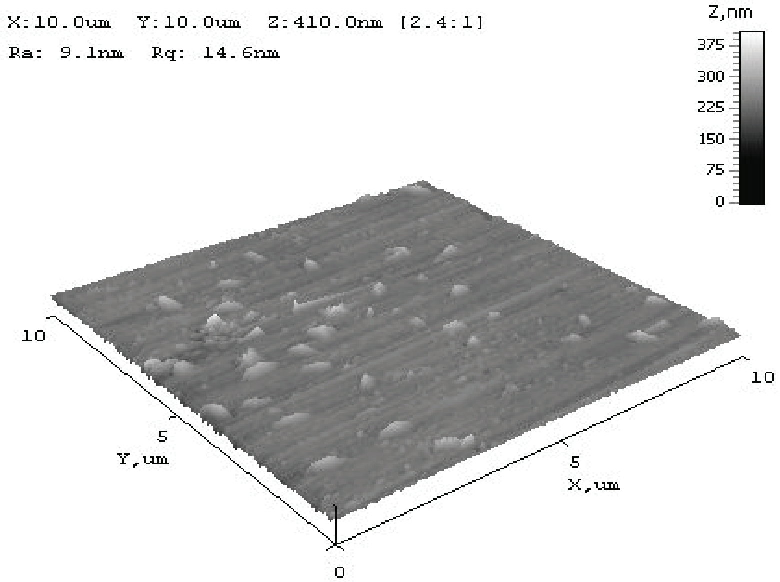


Fig. 7. 3D AFM image of work surface of microbearing sleeve of computer ventilator Xilence Case Fan: (Ra = 9.1 nm)

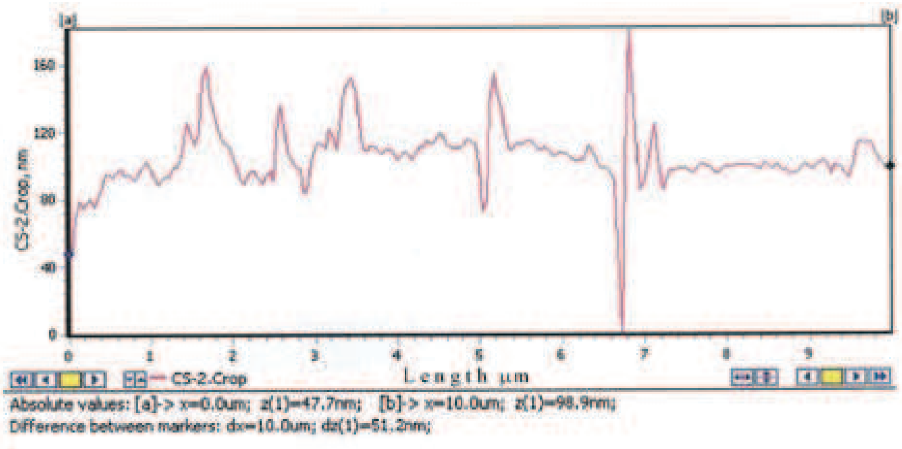


Fig. 8. Profile of work surface of the sleeve presenting roughness height in nano-meters versus sample length in micrometers

6. Micro-hardness and modulus of elasticity studies

Vickers hardness test was performed by indentation of diamond pyramid into sample material with load 100 gram. Average values of Vickers Micro-hardness are obtained for journal 9050 MPa and for sleeve 1150 MPa. Modulus of Elasticity measurements were performed utilizing AFM by indentation of diamond probe with 100 nm radius of tip. References material for measurements was diamond.

7. Conclusions

The measurements performed in micro and nano scale of journal with (3mm diameter) and sleeve surfaces occurring in computer ventilator Xilence Case Fan 92mm, enable to derive the proper model of analytical and numerical calculations and elaboration of real exploitation parameters for micro-bearing lubrication occurring in computer ventilators Xilence Case Fan.

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