Dry wear behavior of Brass alloy before and after Nickel deposition treatment

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Abstract:

Impact of electroplating affidavit of Nickel, treatment on mechanical properties, wear safety, and Vickers hardness of Brass alloy were studied. The examples were dealt with by utilizing electroplating testimony of Nickel on Brass surface specimens . The wear conduct of the samples were considered for all samples prior and then afterward treatment by Nickel statement and the dry wear tests were done by utilizing stick on-plate procedure. The samples were machined as a plate with width of 30 mm and. All samples were led by Scanning Electron Microscopy (SEM), Energy-Dispersive Spectrometry examination (EDS), optical microscopy, and Vickers hardness. The results demonstrated that the dry wear rate were diminished after Nickel affidavit and expanded Vickers hardness values by proportion of 2: 4 : 1. The results demonstrated that the estimations of wear rate for samples having electroplating affidavit of nickel are short of what specimens without deposition .

Introduction

Brass is nowadays considered as one of the most important copper based alloys. In addition, due to the fact that the amount of zinc in such alloys can vary considerably, ranging from 5 to 45 wt%, a wide variety of brass alloys with different technological properties for various commercial and industrial applications can be produced[1]. In particular, up to date brass alloys have been extensively used in automotive, electronic, energy. good mechanical properties and fabricability, high thermal and electrical conductivity and low cost. However, during the last

decades there is an increasing research interest focusing on the tribological properties of brass alloys[2].

Wear is the dynamic loss of material from the working surface of a strong happening as a consequence of relative movement between two surfaces, The straightforward meaning of Wear is a complex wonder. It happens at whatever point surfaces come into sliding contact, even in the vicinity of an oil [3,4] . Electroplating speaks to a standout amongst the most critical technique to diminishment wear rate . it is surface treatment which will grant erosion safety or specific physical or mechanical properties to the surface[5] . Nickel electroplating is a monetarily critical and adaptable surface-completing methodology. Its business imperativeness may be judged from the measure of nickel as metal and salts devoured every year for electroplating [6]. wear and Corrosion execution in useful applications relies on upon nickel thickness and different variables, including the state of the surface before plating. The thickness that ought to be applied depends on the specific application. For example, For drying cylinders and rolls for paper processing, for condenser and calendar rolls for the textile industry, and for externally and internally plated pipe[7,8].In this research we tend to improved the were rate resistance by modification surface hardness and roughness through plating process.

Experimental procedure:

1- Samples preparation

Brass samples were prepared and machined fit as a fiddle of circle with radius of (3.2cm) and thickness of (o.8cm). and then cleaned by distilled water and ethanol to remove any contamination from surface . all samples were subjected to same grade of grinding paper for the purpose of obtaining the same roughness for all samples ,the Chemical composition was conducted for brass samples as shown in table (1) .

2- Wear experiments:

The pin-on-disk machine was used to conduct dry wear experiments with hard disk made from alloy type CK-45. With

Hardness of 50.8HRC . which is used to investigate the dry sliding wear characteristics of brass. The variable parameters of wear are sliding speed (rpm), load (N), contact time (s). All brass samples were subjected to electroplating of nickel by low voltage applied . Nickel Watt bath, composed of 300 g/L of nickel sulfate ($NiSO_4$-$6H_2O$), 50 g/L of nickel chloride ($NiCl_2$-$6H_2O$), 40 g/L of boric acid (H_3BO_3) and 0.1 – 1 g/L brightener. The pH ranges of solution (5 to 5.5). The plating bath was thoroughly cleaned in order to remove solid particles and dirt. Chemical surface preparation followed the mechanical cleaning. The chemical surface preparation was done by subjecting the samples into alkaline detergent cleaner type (carb) solution in order to remove heavy soil, oil and grease. After alkaline cleaning, the samples were dipped into acid (hydrochloric acid) for 30 minutes with concentration 4 M so as to remove traces of oxide film on the surface. Then washing in distilled water and immersed again in alkali solution (sodium hydroxide) for 15 minutes with concentration 4 M , finally washing by distilled water ,then the sample has been weight by sensitive balance of accuracy (0.1mg).The electroplating was performed at different time. The fixed parameter in this process represented by temperature range by (45-56^oC) and applied D.C current of (2.2mA) . Power supply was used with the anodes and cathodes were connected to the positive and negative terminals of the direct current, cathode has been connected to substrate (sample) and anode connected to pure Nickel substrate. After deposition the samples have been weighted to measure the quantities of Nickel deposition on sample.then,wear test has been conducted on samples and compared the results before and after deposition.

Table (1) Chemical composition of Brass alloy

element	Cu	Sn	Pb,	Zn
Content%	65%	20%	5%	10%

Results and discussions :-

sliding time results:-

The effect of sliding time on wear rate results can be shown by Figures (1) for brass samples. Wear rate values were obtained by using weight loss method at fixed parameters such as normal load of (5N),sliding speed of (750 rpm), micro hardness of 137HV and the range of Micro surface Roughness (0.5-0.6 µm). At the beginning of the sliding time the values of wear rates for all samples under tests are high values, this behavior may be due to separate the asperities from the sample surface. The wear rate values are reduced during sliding time between (30-60 min) a semi steady state condition with be reached after about (60 min) of sliding time. but after samples nickel films deposition the wear rate has been reduction as we shown in Fig.(1) , Because of the great hardness layer of nickel is elevated the hardness of sample , and the reduction ratio in wear rate values before and after deposition approach to 50 %

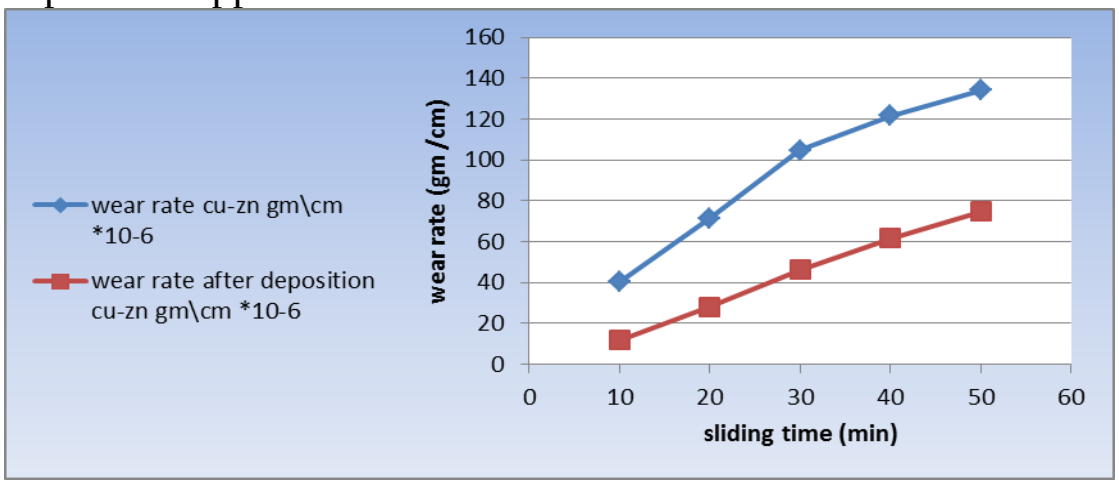

Figure 1 wear rate as a function of sliding time before and after electroplating

Sliding Speed results:

Different sliding speed were taken to investigated the effect of sliding speed on wear rate before and after nickel electroplating . Wear rate values were calculated at the fixed other parameter such as Normal load (5N), sliding time (15min), average Micro Hardness of 137 HV, and average Surface Roughness(0.7-0.8).

The effect of nickel electroplating very clearly shows in figure 1 that the wear rate value of the samples after nickel deposition less than of the samples before nickel deposition, this behavior may be explain due to the layer hardness of nickel compared with brass. In general the wear rate for all sample decrease when the sliding speed increases this due to reduce the fraction force between the mating parts.

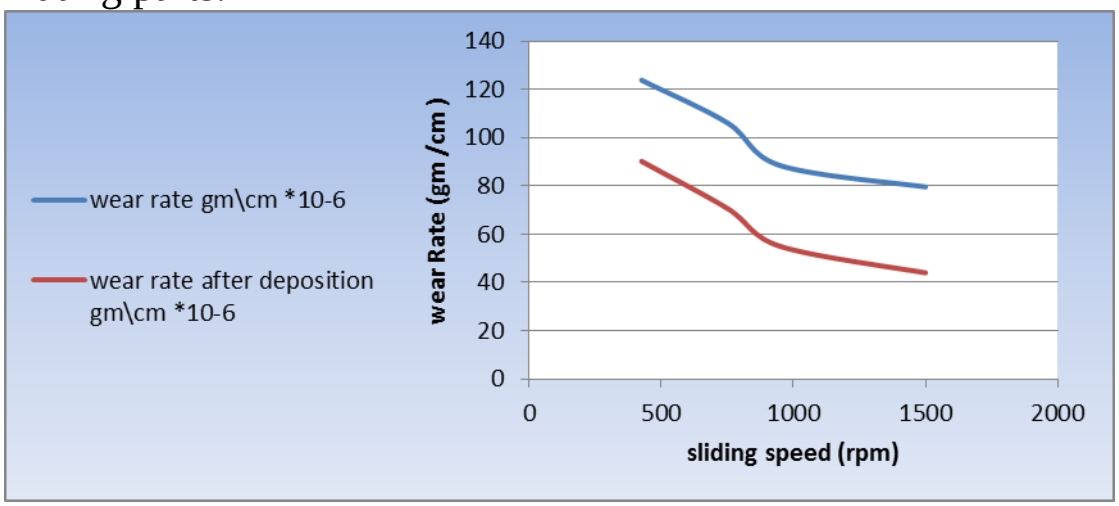

Figure 2 wear rate as a function of sliding speed before and after electroplating

Normal Load results:

Figure (3) represented the wear rate values as function of Normal Loads). Normal Load experiments were conducted at constant parameters which were mentioned in the previous sections . The wear rate values for all samples will increase at the rang of Normal Loads(2.5-7.5 N) the reason of this behavior may be due to increase the weight loss at the beginning of testing at the high Normal Loads of (10 N -15 N) a steady stat condition will be began, the reason of this behavior due to flatting of the specimen, reduce of the surface roughness and to the increase the hardness of samples, because of work hardening and the temperature of sample elevated, at this time the sample will quenched by lubricant film and for this reason sample has been hardened. From the Figures can be shown that the wear rate of Aluminum sample is higher than other samples and the Brass alloy is less than others. Figure (4) the scanning electron

microscope for samples before and after nickel deposition and can be shown clearly the effect of nickel electroplating .

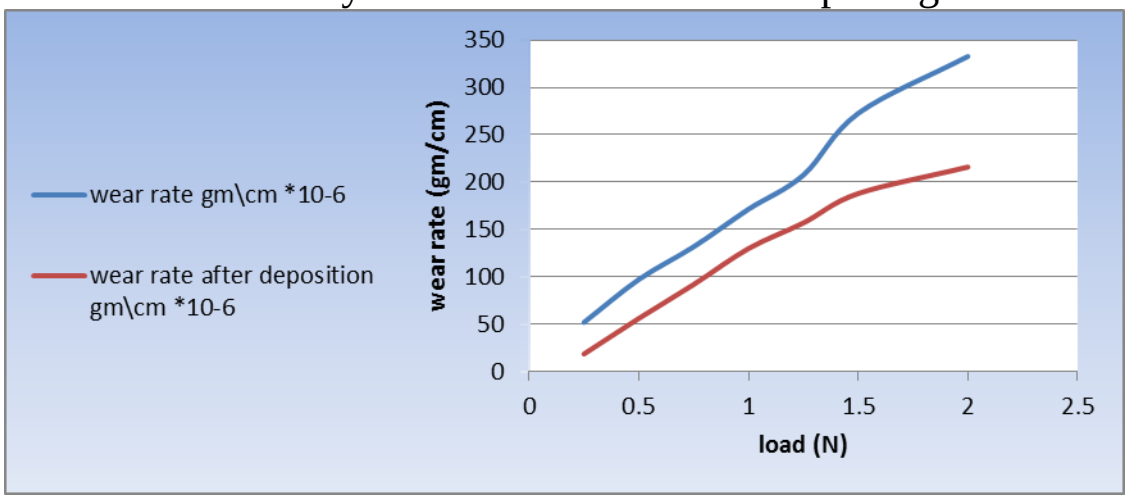

Figure 3 wear rate as a function of normal load before and after electroplating

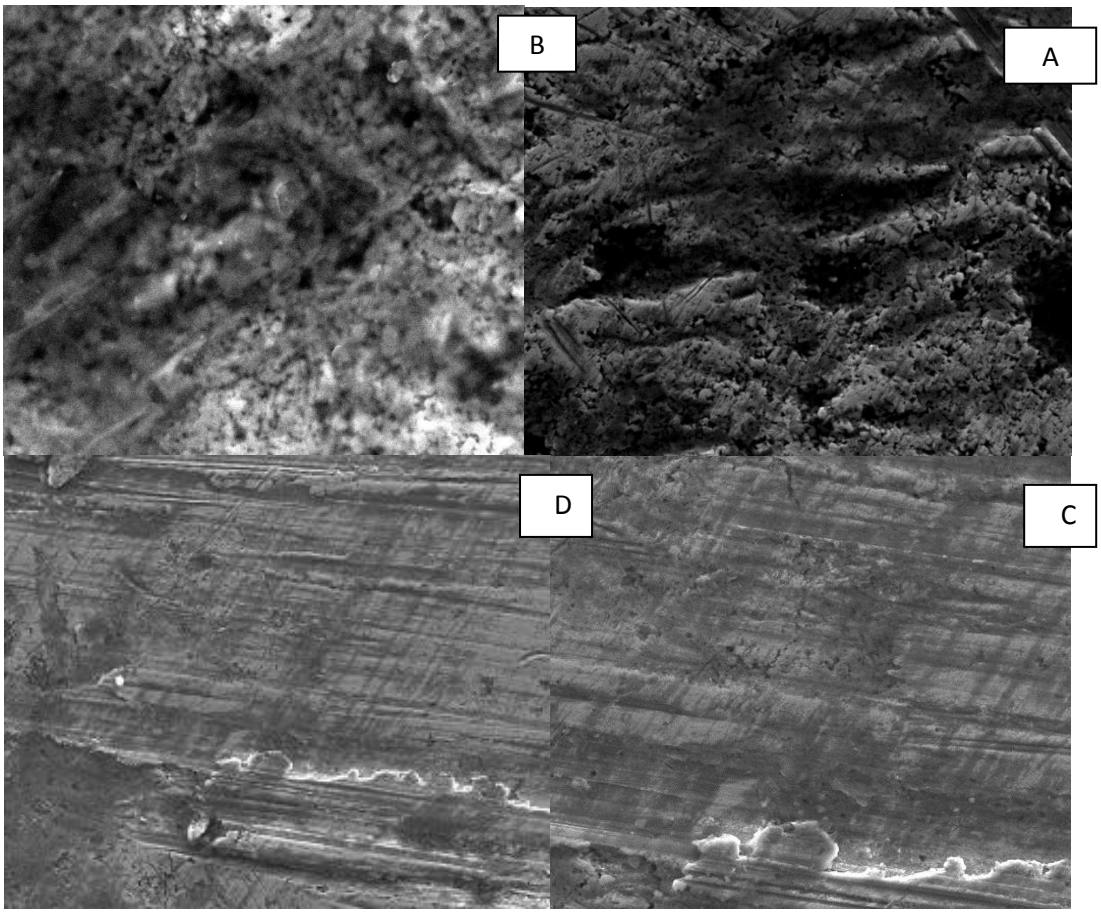

Fig.(4) SEM images for brass A-before electroplating B- after electroplating at sliding time 30min. c- after electroplating at sliding speed 100rpm D- after electroplating at normal load 2.5 N

Conclusions:

Nickel electroplating reduced the wear rate by approximately 50% at different sliding time and different normal loads while the same process reduced the wear rate of brass alloy samples by 40% at different sliding speed .

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سلوك البلى الجاف لسبيكة البراص قبل وبعد معاملته بترسيب النيكل

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الخلاصة:

تأثير ترسيب النيكل على الخصائص الميكانيكية مثل البلى وصلادة فيكرز لسبيكة البراص ثم دراستها . ركزت التجارب على استخدام الطريقة الكهروكيميائية لترسيب النيكل على سطح البراص . تم اجراء تجارب البلى على جميع النماذج قبل اجراء عملية الترسيب . وكذلك اجرائها بعد عملية الترسيب . تم تهيئة النماذج وتشغيلها بسمك 30mm . اجريت القاسات لجميع العينات باستخدام المجهر الألكتروني الماسح وتقنية طيف تشتت الطاقة وكذلك قياس الصلادة بوحدات فيكرز، وقد اظهرت النتائج ان البلى يقل بنسبة كبيرة بعد استخدام ترسيب النيكل عما عليه قبل الترسيب .