

** 研究課題 **

高真空用歯車のトライボ性能評価

Tribological Evaluation of Surface Modified Gear in Vacuum

表面改質ローラの高真空トライボロジー特性

Tribological Characteristics of Surface Modified Roller in High Vacuum

高機能材料の高温トライボロジー

Tribological Characteristics of High Functional Materials

改質表面の真空高温摩擦・摩耗特性

Friction and Wear Characteristics of Modified Surface for Space and Air Crafts in Vacuum and at High Temperature

表面改質材のトライボロジーとその評価・解析

Tribology of Surface Modified Materials and Its Estimation and Analysis

軟質コーティングによるピッチング強さの改善

Improvement of Pitting Durability by Soft Coating

ショットピーニング粉末焼結歯車の疲れ強さと動的性能

Fatigue Strength and Dynamic Performance of Shot-peened Sintered Powder Metal Gears

複合表面処理歯車の面圧強さ

Surface Durability of Multiplex Surface Treated Gears

粉末焼結ローラの面圧強さに関する研究

A Study on Surface Durability of Sintered Powder Metal Rollers

浸炭硬化ローラの面圧強さに及ぼすショットピーニングの影響
Effect of Shot Peening on Surface Durability of Case-Hardened Rollers

制振合金歯車の面圧強さと動的性能
Surface Durability and Dynamic Performance of Damping Alloy Gears

多孔質ファインセラミックス製静圧ガイドに関する研究
A Study on Hydrostatic Guide Made of Porous Fine Ceramics

[** 研究報告 ** \(9 件 \)](#)

Tribological Behaviors of Multiplex Plated Stainless Steel Rollers in High Vacuum
Akira YOSHIDA, Masahiro FUJII and Tomoki HARANO* (*Anan National College of Technology)
Proceedings of the International Tribology Conference Nagasaki 2000, Vol.II, pp.1421-1426, 2001

Two-cylinder test was carried out under non-lubricating condition in high vacuum to investigate the wear and friction behavior of electroless Ni plating and multiplex plating based on electroless Ni-P alloy plating. Ni-P alloy plating (Ni-P), two kinds of multiplex plating, that is Ni-P with PTFE particles (Ni-P+PTFE) and Ni-P with BN particles, were employed. The initial friction coefficient of Ni-P plating roller with 0.2 μ m PTFE particles was the smallest in all test rollers. The friction behavior of Ni-B plated roller was the most stable in all test rollers and so, the surface profile was the smallest. In case that the elastic modulus of plated layer is smaller than that of substrate, the calculated shear stress in plated layer has the maximum value at the position near the boundary between the substrate and the layer without frictional force. The calculated shear stress around a PTFE particle was larger than that around a BN particle in the plated layer.

Fatigue Life Assessment of Surface Hardened Sintered Rolling under Sliding-Rolling Contact Condition
Akira YOSHIDA, Yuji OHUE*, Masanori SEKI (*Kagawa University)
Proceedings of the International Conference on Mechanical Transmissions ICMT2001, pp.472-477, April 2001

To assess the surface durability of sintered machine elements, the fatigue lives of 28 kinds of sintered rollers under a sliding-rolling contact condition were estimated by using the Paris's law based on the fracture mechanics. The fatigue tests were conducted using two cylinders testing machines. The stress intensity factor for the mode II under a condition of Hertzian contact was calculated using FEM. The value of the stress intensity factor became larger as the crack length and the pore size became longer. It could be clarified that the fatigue lives of the sintered rollers

depended on the pore diameter, the distance between pores and its hardness. It was important to take the pore distribution into consideration to assess the fatigue lives of the sintered rollers.

耐摩耗性鋼および表面改質処理材のスcaffing特性

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日本マリンエンジニアリング学会誌, 36巻4号, 31頁~37頁, 2001年4月

機械摺動部材の高強度化, 耐久性向上および信頼性向上を目的に, 耐摩耗性と耐scaffing性を改良した低合金鋼(WRS)を開発した. 本研究では, 二円筒によるscaffing試験を行い, WRSのscaffing強さと損傷形態を調べた. WRSは自己潤滑性を有し, 従来鋼に比べ良好な耐scaffing性を示した. WRSの耐scaffing性は硬さに依存し, 低硬度の場合に耐scaffing性は高く摩擦係数は低かった. Ni-Pめっき材の耐scaffing性は高かったが, 試験初期に浸硫層が消失する浸硫処理のscaffing特性は母材のそれと等しかった. scaffing発生により表面改質処理材母材の表面に30~50 μm の厚さで白層を生じた. この白層は, 熱的エネルギーと機械的エネルギーによって表面近傍のセメントタイトの一部が固溶し, 炭素が過飽和固溶したマルテンサイトと考えられた.

イオン窒化粉末焼結ローラの面圧強さに関する研究(粉末粒子径の影響ならびに面圧強さと硬さの関係)

吉田 彰, 大上祐司*, 關 正憲, 荒瀧拓之**, 烏野 勇*** (*香川大学, ** (株)永谷園, ***住友金属工業(株))

日本機械学会論文集(C編), 67巻658号, 1993頁~1999頁, 2001年6月

イオン窒化粉末焼結ローラの面圧強さに及ぼす粉末粒子径と, 表面硬化粉末焼結ローラの面圧強さと硬さの関係について報告している. 粉末粒子径が小なるほど, その面圧強さはより高くなる傾向にあった. 損傷形態はスポーリング損傷であり, その損傷深さは硬さに対するせん断応力の比の振幅 $A(\tau_{yz}/HV)$ が最大となる深さとほぼ一致した. その最大となる深さでの振幅について, 焼結材における面圧強さにおけるせん断応力と硬さの関係を調べたところ, 気孔分布が同じであれば, 面圧強さと硬さはほぼ比例関係にあるが, 気孔分布が異なると, 硬さによって面圧強さを一義的に決められないことを明らかにした.

Study of Optimum Dispersed Particle Size for Wear of Multiplex Plated Surfaces

Akira YOSHIDA, Masahiro FUJII and R.S.Dwyer-Joyce* (*University of Sheffield, UK)

Abstracts of Papers 2nd World Tribology Congress WTC2001, p.521, September 2001

Twin-disk tests were carried out under non-lubricating conditions in high vacuum to investigate the wear and friction behaviour of multiplex platings based on electroless Ni-P alloy. Two kinds of multiplex plating, which are the Ni-P plating with PTFE particles and the Ni-P plating with BN particles, were employed. The wear rate of both plated layers with BN particles and with PTFE particles increased with increasing content of dispersed particles. The wear rate of the layer with PTFE particles was greater than that with BN particles. The influence of elastic modulus and

radius of dispersed particles on stresses in the plated layer was investigated with FEM analysis. The maximum values of Mises stress and maximum shear stress in the plated layer increased with increasing friction coefficient, with increasing particle content and with decreasing elastic modulus of particles. The radius of the dispersed particles hardly influenced the maximum values of Mises stress and maximum shear stress in the plated layer. The wear behaviour obtained in the experiment could be well explained by the calculated stress field.

プラズマ浸炭硬化粉末焼結ローラの面圧強さに関する研究(面圧強さに及ぼすショットピーニング投射速度と投射時間の影響)

吉田 彰, 大上祐司*, 關 正憲, 荒瀧拓之**, 烏野 勇*** (*香川大学, **(株)永谷園, ***住友金属工業(株))

日本機械学会論文集(C編), 67巻661号, 2961頁~2968頁, 2001年9月

粉末焼結ローラにプラズマ浸炭とショットピーニングを施し, そのローラを試験ローラとして二円筒滑り転がり接触条件下で疲れ試験を行い, ローラの面圧強さとショットピーニングの影響について検討した. ショットピーニングによりローラ表面付近の硬さと圧縮残留応力が増大したが, ローラ表面付近の気孔がつぶれ, 表面粗さが増加した. 疲れ試験による試験ローラの損傷はスポーリング損傷が主体であり, 気孔がつぶれた場所で損傷が発生していた. さらに硬さに対する両振りの直交せん断応力の比の振幅が最大となるローラ円周面からの深さと損傷深さとがほぼ一致していることを示した.

Effect of Shot Peening on Surface Durability of Plasma Case-Hardened Sintered Powder Metal Rollers

Akira YOSHIDA, Yuji OHUE* and Masanori SEKI (*Kagawa University)

Proceedings of the JSME International Conference on Motion and Power Transmissions MPT2001-Fukuoka, Vol.I, pp.193-198, November 2001

The machine elements of sintered powder metals are generally cheaper than those of steels, while the machine elements of sintered powder metals have a disadvantage in fatigue strength. Therefore, the purpose of this study is to investigate the influence of shot peening on surface durability of sintered powder metal rollers under a sliding-rolling contact condition. The test rollers with 30 mm and 60 mm in diameter were made of partially alloyed powders which were compacted and sintered. After a finishing grinding the surface treatments of the test rollers were plasma case hardening and shot peening. The shot peening conditions differed in shot velocity, shot diameter, shot hardness and peening time. The compressive residual stress, the hardness and the surface roughness of all rollers increased and the pores near the surface of those were deformed by the shot peening. However, in the case of the test rollers with 60 mm in diameter, the pores not only in near by the surface but also at the depth of about 2000 μ m were deformed by the hard shot peenings. The surface durabilities of the only mild shot-peened rollers with 60 mm in diameter were higher than that of the unpeened roller in these experiments. The failure mode of the rollers was mainly spalling. The spalling cracks propagated from the sharp notches of the pores deformed by the shot

peening. A further important point is that the failure depth agreed almost with the depth where the amplitude $A(\tau_{yz}/HV)$ of the ratio of the orthogonal shear stress to Vickers hardness became maximum. It can be considered that the shear stress below the contact surface of the shot-peened rollers increases, since the increase of the surface roughness by the shot peening results into the increase of the frictional force between the rollers. Therefore, the result of this study clearly shows that the mild shot peening without sharp deformed pore and too large surface roughness should be selected in order to improve the surface durability of the sintered rollers.

Observation of Crack Propagation Behavior in Steel Roller under Sliding-Rolling Contact for Evaluating Its Fatigue Life

Akira YOSHIDA, Yuji OHUE* and Masanori SEKI (*Kagawa University)

Proceedings of the JSME International Conference on Motion and Power Transmissions MPT2001-Fukuoka, Vol.I, pp.211-216, November 2001

In order to assess the sliding-rolling contact fatigue lives of surface-hardened sintered rollers from the view point of linear fracture mechanics, the crack propagation behavior was investigated under a sliding-rolling contact condition. The surface-hardened rollers which have three kinds of artificial defects were fatigue tested, and the crack propagation rate was measured. The stress intensity factor was calculated using the finite element method. The crack propagated from the hole was almost parallel to the roller surface. Therefore, it could be said that the crack propagation under a sliding-rolling contact condition was in the mode II. The parameters m and C in Paris's law were obtained from this experiment. Using those parameters, the fatigue lives of the surface hardened sintered roller were estimated. The estimated fatigue lives were almost the same as the experimental ones. The fatigue lives of the sintered rollers depend mainly on the pore distribution and the hardness. It could be considered that the cracks of the sintered rollers occurred from many mean pores and propagated from one pore to another pore.

Effect of Surface Modified Layer on Rolling Fatigue Strength

Akira YOSHIDA and Masahiro FUJII

Proceedings of the JSME International Conference on Motion and Power Transmissions MPT2001-Fukuoka, Vol.I, pp.249-254, November 2001

Surface modified rollers and ball bearings were fatigue-tested under pure rolling contact conditions. Electroless Ni-P alloy plating and sulfurizing treatments were employed. Failure mode of all rollers and bearings was spalling/flaking due to subsurface cracking. Fatigue lives of both rollers and bearings were improved by surface modifications. The influence of elastic modulus of a plated layer on contact pressure and subsurface stresses was examined under line contact and point contact conditions. The contact pressure and subsurface stresses were reduced by the soft surface modified layer, especially at the edge of the contact width under the line contact condition. The conformity due to wear of the plated layer led to the reduction of the contact pressure and the subsurface

stresses. The reason why the rolling fatigue strengths of surface modified rollers and bearings were higher than those of the non-coated ones would be due to the smaller contact pressure and the smaller subsurface stresses by the smaller elasticity as well as the conformity of the plated layer.

** 学術講演 ** (18 件)

Masahiro FUJII

Influence of Surface Modification on Rolling Contact Fatigue Strength

Tribology at Twelve, University of Sheffield 2001.2.2

吉田 彰, 大上祐司*, 関 正憲, 川崎俊彦 (*香川大学)

滑り・転がり接触条件下のき裂伝ば挙動の観察

日本機械学会中国四国支部第 39 期総会・講演会講演論文集, No.015-1, 講演番号 901, 311 頁-312 頁

2001.3.6

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ショットピーニングローラの面圧強さに関する研究

日本機械学会中国四国支部第 39 期総会・講演会講演論文集, No.015-1, 講演番号 902, 313 頁-314 頁

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日本機械学会中国四国支部第 39 期総会・講演会講演論文集, No.015-1, 講演番号 909, 327 頁-328 頁

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浸炭硬化鋼製ローラの面圧強さに及ぼすショットピーニングの影響

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日本機械学会 2001 年度年次大会・講演論文集(), No.01-1, 講演番号 F-0332 ,165 頁-166 頁 2001.8.30

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Study of Optimum Disperased Particle Size for Wear of Multiplex Plated Surfaces

Abstracts of Papers 2nd World Tribology Congress WTC2001, pp.521 2001.9.6

吉田 彰, 藤井正浩, 岡内健

Ni 系めっき表面の真空・高温摩擦摩耗特性

日本設計工学会平成 13 年度秋季研究発表講演会講演論文集, 講演番号 21, 69 頁-72 頁 2001.9.29

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ショットピーニング鋼製歯車の面圧強さと動的性能

日本設計工学会平成 13 年度秋季研究発表講演会講演論文集, 講演番号 30, 101 頁-104 頁 2001.9.29

藤井正浩

粒子分散複合めっき層の強度に及ぼす分散粒子径の影響について

中国四国機素潤滑設計技術研究会 2001.11.9

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滑り転がり接触条件下における鋼製ローラのき裂進展挙動

日本トライボロジー学会トライボロジー会議予稿集宇都宮, 講演番号 3D14, 447 頁-448 頁 2001.11.8

Akira YOSHIDA, Yuji OHUE* and Masanori SEKI (*Kagawa University)

Effect of Shot Peening on Surface Durability of Plasma Case-Hardened Sintered Powder Metal Rollers

Proceedings of The JSME International Conference on Motion and Power Transmissions
MPT2001-Fukuoka, Vol.I, pp.193-198 2001.11.15

Akira YOSHIDA, Yuji OHUE* and Masanori SEKI (*Kagawa University)

Observation of Crack Propagation Behavior in Steel Roller under Sliding-Rolling Contact for Evaluating Its Fatigue Life

Proceedings of The JSME International Conference on Motion and Power Transmissions
MPT2001-Fukuoka, Vol.I, pp.211-216 2001.11.15

Akira YOSHIDA and Masahiro FUJII

Effect of Surface Modified Layer on Rolling Fatigue Strength

Proceedings of The JSME International Conference on Motion and Power Transmissions
MPT2001-Fukuoka, Vol.I, pp.249-254 2001.11.17

吉田 彰

歯車の材料と熱処理

講習会「最新の機器設計に必要な歯車技術の基礎から応用まで(基礎編)」教材,日本機械学会, pp.35-42
2001.12.21

** 総説・解説 ** (1件)

歯車への導入

吉田 彰

トライボロジスト, 46 巻 4 号, 43 頁 ~ 44 頁, 2001 年 4 月

トライボロジスト(日本トライボロジー学会)の特集号:リファレンス オブ リファレンスで,これから歯車の研究に着手する若手研究者のために,基礎となる教科書,解説書,専門書,代表的論文,最新情報等の紹介および解説を行った.

** 特 許 ** (1件)

歯車動的性能の評価システム及び評価手法

吉田 彰, 大上祐司, 本郷俊明

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