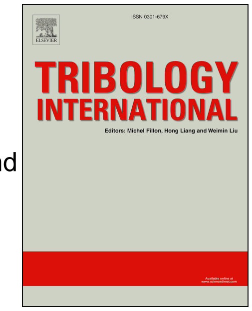
# Accepted Manuscript




Micro-porous layer generated during gas nitriding and induction quenching compound treatment affects tribological properties

Zhang Guosong, Cui Hongzhi, Zhang Hongyun, Cheng Guiqin

PII: S0301-679X(17)30586-8

DOI: 10.1016/j.triboint.2017.12.028

Reference: JTRI 5012

To appear in: *Tribology International*

Received Date: 23 September 2017

Revised Date: 16 December 2017

Accepted Date: 20 December 2017

# Micro-porous layer generated during gas nitriding and induction quenching compound treatment affects tribological properties

Zhang Guosong*[a], Cui Hongzhi*[a], Zhang Hongyun[b], Cheng Guiqin[c]

[a]*School of Materials Science and Engineering, Shandong University of Science and Technology, Qingdao 266590, China*

[b]*SACCKE Qingdao Marinr Boiler Co.,Ltd, QingDao 266590, China*

[c]*Qingzhou Haidun Hydraulic Machinery Manufacturing Co Ltd, Qingzhou 262500, China*

**Abstract**

In this study, a micro-porous layer (MPL) about 40 μm depth was fabricated on the surface of 55CrMo steel after gas nitriding and induction quenching (GN+IQ) hybrid treatment. A zirconia ceramic ball was used as the counter-body, and the tribological performance of MPL was analyzed under dry sliding and starved lubrication conditions with loads of 20 N and 100 N. Under dry sliding conditions, the wear rate of the MPL was higher during initial stages under a larger load of 100 N, however, the coefficients of friction (COF) decreased after GN+IQ treatment compared to induction quenching under either load. Under starved lubrication conditions, the COF decreased and remained relatively stable throughout the test process that owe to the extruded oil stored in the MPL, moreover, the anti-wear performance of GN+IQ hybrid treated sample was also enhanced by a single abrasive wear mechanism as opposed to a combination of adhesive wear and abrasive wear of in the IQ-treated sample.

**Keywords:** Tribological performance; Micro-porous layer; GN+IQ hybrid treatment; 55CrMo steel

## 1. Introduction

About 90% of all practical engineering component failures are surface-initiated. Surface strengthening and proper lubrication are crucial for reducing friction and improving service life. Nitriding is an effective surface strengthening technique that provides high surface hardness [1, 2], low friction [3, 4], and favorable wear and/or corrosion resistance [5, 6]; it is commonly utilized in the industry to ensure high performance, low cost, and good processability [7]. The thickness limitation of this process and the resulting brittleness limit its wider application, however.

Researchers have developed a series of hybrid treatments to modify the microstructures and properties of nitrided layers. Takashio et al. [8], for example, found that high-frequency induction quenching of soft nitriding steels promotes the diffusion of nitrogen into the matrix, resulting in higher hardness than that produced by single soft nitriding or quenching. The hardness layer of 40CrNiMoA steels can be much deeper than that produced by