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**A STUDY OF MICROSTRUCTURE ALTERATION IN AISI 52100 BEARINGS DUE TO CLASSIC ROLLING CONTACT FATIGUE AND WHITE ETCHING CRACK**

**TRACK OR CATEGORY**

Wind Turbine Tribology

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**INTRODUCTION**

Formation of the subsurface White Etching Crack (WEC) has been identified as a cause of detrimental failures in SAE 52100 and SAE 4320 bearing steels that appears to be different from the classic Rolling Contact Fatigue (RCF) in a wide range of rolling contact applications. Typically, RCF failures are due to medium to high contact pressure and high rolling cycles, where a sequence of microstructural transformations takes place, starting from Dark Etching Regions (DER) then Low- and High- Angle Bands (LAB/HAB) and leading to long but finite life of bearings. Little detailed research has been conducted in recent years to investigate the differences between RCF and WEC.

This study, for the first time, has analysed the microstructure changes in DER, HAB and LAB using a combination of advanced microstructure characterisation techniques, including Electron Channelling Contrast (ECC), Scanning Electron Microscopy (SEM), Electron Backscatter Diffraction (EBSD) in combination with Energy Dispersive X-ray spectroscopy (EDX), to reveal differences and relationships between RCF and WECS.

**MATERIALS AND EXPERIMENTAL METHODOLOGY**

DER, LABS, HABs and WECs being investigated in this study were from standard AISI 52100 (100Cr6) through-hardened martensitic steel bearings subjected to RCF testing stopped at different stages when the relevant microstructural transformation occurred.



**Computer Aided Image Enhancement of Tongue for Diagnosis in Ayurvedic Medical Treatment**

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**Abstract**

Ayurveda is one of the traditional medical systems practiced in India and south Asian countries from ancient times. Tongue diagnosis is one of the important areas in physical diagnosis of treatment of health disorders in Ayurveda. The diagnosis is usually carried out by the medical practitioner with visually understanding the tongue, but the process of understanding the tongue image is not an easy task to carry out. The difficulty arises because of the irregular shape of the tongue, overlapping of colors, effect of outside light, dominance of saliva on cracks and buds etc. In this paper, we propose an application of computer aided digital image enhancement methods for processing the tongue image to highlight the true color and white coating, cracks, pimples/buds etc., so that the practitioner can get more valuable information compared to direct visual examination of the tongue. The method mainly consists of two techniques; first, color image filtering and enhancement for identifying the true nature of colors on different parts of the tongue and to bring out white coating; second, contrast enhancement and image sharpening in grey scale for highlighting the shape, cracks, buds and pimples. The aim of our method is to help in reducing the complexity in tongue image understanding for the practitioner. The data of the experimental results reveal that our method produces significant useful result for the tongue diagnosis.

**Keywords:** Ayurveda; Tongue diagnosis; Digital Image Processing; Image enhancement.

**Introduction**

Ayurvedic medical system is one of the popular medical systems followed in India and other south Asian countries along with Allopathy, Homeopathy and Naturopathy. Ayurvedic Medical practitioners rely on noninvasive diagnosis like understanding symptoms on patient's bodies to tell them when something is wrong in their body. Besides the skin, hair, eyes, lips and nails as indicators of internal imbalances, the tongue also provides them with vital clues [1]. In Indian Ayurvedic medicine, observation of the tongue describes the current state of an individual's health, as well as their inherited constitution. Tongue diagnosis is a way of viewing inherited tendencies and illnesses that could occur, depending upon the person's nature and lifestyle. It reveals existing disease process and is a means of health evaluation. Although not backed by documented scientific research, tongue diagnosis dates back several thousand years, and has long been used as an investigative tool by practitioners of the traditional schools of medicine. At one time, both pulse and tongue assessments were important diagnostic techniques used in the Western medicine



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