INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

DIRECTION DE LA RECHERCHE

→ SOUTENANCE D'UNE THESE DE DOCTORAT →

(la soutenance est publique)

NOM :	RUELLAN DU CREHU
Prénoms :	Arnaud
Fonction :	Doctorant
Laboratoire INSA :	LaMCoS - MATEIS
Date et heure de soutenance :	Vendredi 5 Décembre 2014 à 14h00
Lieu :	INSA de Lyon – Amphi Chappe – (Bâtiment TC)
Titre de la these:	*Tribological Analysis of White Etching Crack Failures in Rolling Element Bearings*
Ecole Doctorale :	MEGA
Rapporteurs :	Pr. Gerhard POLL et Pr. Jorge SEABRA
Jury :	Pr. Motohiro KANETA Pr. Michel FILLON Pr. Xavier KLEBER M. Bernard LIATARD Pr. Gerhard POLL Pr. Jorge SEABRA Pr. Fabrice VILLE

RESUME :

Despite constant expansion and engineering progress, wind turbines still present unexpected failures of heavy duty mechanical components drastically affecting the cost of energy. Among the most prevalent tribological failures in wind turbine rolling element bearings, a peculiar rolling contact fatigue mode has been associated to broad subsurface three-dimensional branching crack networks bordered by white etching microstructure, and thus named White Etching Cracks (WEC).

Compared to conventional microstructural alterations, WECs tend to develop at moderate loads and cycles eventually leading to premature failures that remain unpredictable using fatigue life estimations. Far from being generic to specific manufacturers, WECs occur in various industrial applications, for various bearing types, components, lubricants, steels grades and heat treatments. As WEC occurrences present no common evident denominator, they remain delicate to reproduce on laboratory test rigs without prior artificial hydrogen charging, so that no consensus on WEC formation mechanisms have been confirmed yet.

In this study, a thorough tribological analysis of WEC formation mechanisms has been led. Expertise protocols have been established to best reveal and observe WECs that commonly develop at unconventional locations versus the contact area. First analysis of WEC reproductions on standard rolling element bearings either hydrogen precharged or kept neutral have signified that artificial hydrogen charging, commonly employed to apprehend the failure mode, results in similar WEC morphologies but tends to alter WEC tribological initiation.

In consequence, WEC reproductions in remarkably different configurations but without hydrogen charging have been compared in order to propose a better understanding of WEC surface-affected formation mechanisms: first, initiation via tribochemical hydrogen permeation at nascent steel surfaces formed either directly at the raceway or at surface microcracks flanks and second, propagation by local hydrogen embrittlement at crack tips function of the stress state.

An extensive root cause analysis have then been led suggesting that WEC may be associated to various combinations of macroscopic operating conditions that often interact and come down to similar tribological parameters including high sliding energy thresholds, specific lubricant formulations and tribochemical drivers such as water contamination and/or electrical potentials. Further investigations on a minimalist twin-disc fatigue tribometer have provided additional evidence that WEC influent drivers are non-self-sufficient, supporting that WEC formation mechanisms rely on a subtle equilibrium between tribo-material, tribo-mechanical and tribo-chemical drivers that all should be mastered to design efficient and durable countermeasures.