Project title	Development of Compound Bearing Concept
Project number	TG3-2
Organisation	Swerea
Project leader	Sven Haglund
Other participants	Hans Kristoffersen, Karin Frisk
Report for	2013-03-13 – 2013-09-30
Participating companies	SKF, Erasteel, Bodycote

Project description

The aim of the project is to suggest materials combinations for a compound bearing with a low-cost base material and a high performance material in the raceway, especially designed for demanding wind turbine applications. The raceway is produced by a powder metallurgical route and HIP-ed together with the base material to a single bearing washer.

Summary of the project activities:

- Identify the demands on the materials in the raceway and in the core.
- Equilibrium and kinetic simulations of the chemical reactions between selected core and raceway materials during HIP-ing are performed. Equilibrium calculations will give the answer to what reactions that may occur and some materials combinations may be excluded already at this stage. Kinetic simulations will show how far the alloying elements may diffuse and how far the reactions will completed.
- FEM-simulation of residual stresses formed during the heat treatment of the compound washer. Factors influencing the residual stresses will be identified. Conditions causing tensile stresses in the raceway or too large stresses during cooling risking interface delamination will be avoided.
- HIP-experiments on selected materials combinations will be performed on laboratory specimens. The specimens are carefully studied both metallographical and chemically.
- Contact fatigue properties of a raceway material will be evaluated. Due to time limitations within the project this is not done on compound washers but on washer in solid raceway material made by powder metallurgy so that the defect populations are comparable to defects in an actual compound bearing. The tests are performed as bearing tests.
- A prototype bearing washer will be manufactured within the project.

Results

Equilibrium and kinetic simulations were carried out with three raceway materials in combination with nine different raceway materials. The most promising combinations had the same carbon activity in raceway and core materials at HIP-temperature in order to avoid long range diffusion of carbon. Carbon diffusion could give local changes in Ms-temperatures as well as dissolution or precipitation of carbides which could cause cracking or poor mechanical properties. 14 of the combinations were considered suitable.

The FEM simulations showed that the Ms-temperature of the core should be higher than the Ms-temperature of the raceway material in order to induce compressive residual stresses in the raceway. The simulations also showed that the raceway thickness should be as thin as possible in order to maximise the compressive residual stresses in the raceway and to minimise the tensile stresses in the core

Four materials combinations were tested in small scale HIP experiments. The investigated combinations, M50//SS2244, XD15NW//Ovako 225A, APZ10//Ovako 225A and APZ10//Ovako 277L all showed good bonding between core and raceway material and no unwanted precipitation in the interface. All combinations were found suitable for further studies. The experimentally measured concentration profiles agreed well with calculations.

Demonstrator compound washers are being manufactured in the combinations M50 (raceway) // SS2244 (core) and XD15NW (raceway) / Ovako225A (core). The manufacturing was not completed at the time of writing this annual report.

Deviations from project plan

Manufacturing of test rings and demonstrator washers were delayed partly due to high production load on Bodycote and partly to unexpectedly long time for machining of test ring.

Publications

1. S. Haglund, K. Frisk, S. Caddeo Johansson, H. Kristoffersen, *Development of Compound Bearing Concept for Wind Power Applications, part 1*, Swerea KIMAB report

Submitted

1. K. Frisk, C. Luo, S. Caddeo Johansson, S. Haglund, N. Petterson, I. Strandell, *Compound Materials by PM-HIP*, Accepted for publication in Powder Metallurgy

External activities