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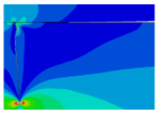

THE GEOMETRIC AND TRIBOMETRIC CHARACTERIZATION OF THE FRICTION COMPONENTS OF AN ARTIFICIAL HIP JOINT

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INTRODUCTION

Characterization of the surfaces of the prototipe friction pair components should include two approaches: surface topography measurements (geometric studies) and tribological tests (tribometric studies).

The first approach of characterization consists of the studies of the surfaces geometrical structure (after a technological process) and the mechanisms of wear as well as the wear products (after an operational process). Whereas, the second approach of the characterization consists of the studies that aim to establish the tribological properties of materials (friction torque).

The combination of these two approaches makes it possible to rationally solve research problems in the field of characterizing the surface topography of friction pair components. Thanks to this, it is possible to optimize the functionality of the tribological system.

MATERIALS AND METHODS

The subjects of studies and analysis were ceramic material used in conjunction with a polymeric material in friction pair of artificial hip joint: polymeric acetabulum and ceramic femoral head.

The finishing process of ceramic parts included two main operations - grinding (shape as well as a third dimension – form/dimater) and lapping (two treatments surface texture and functional properties of the machined surface – were obtained).

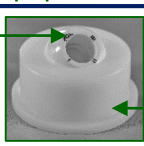
As the result of technological process for ceramic parts, two different kinds of surface topography – CER1 and CER2 (defined by Ra parameter, where $Ra_{(CER1)} > Ra_{(CER2)}$) were obtained.

The finishing process of the polymeric parts POL also included two operations - turning and polishing.

Materials – friction pair and properties of materials

CER

Density = 6.05 g/cm^3
Young's Module = 209 GPa
Poisson's ratio = 0.23/0.32

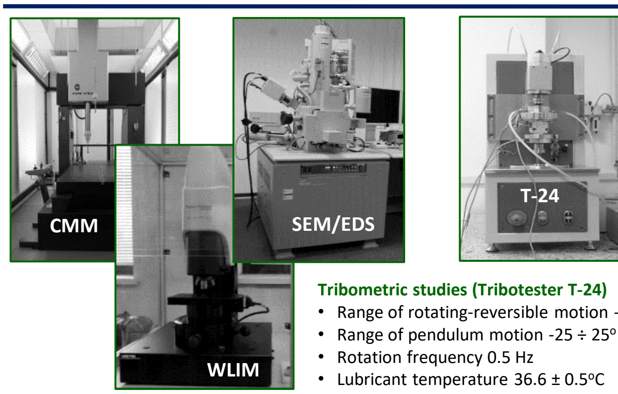


POL

Density = 0.937 g/cm^3
Young's Module = 0.66 GPa
Poisson's ratio = 0.46

Three measurement instruments were used to study machined and worn surface topography: coordinale measurement machine (CMM), scanning electron microscope (SEM/EDS) and white light interference microscope (WLIM). The multi-scale analysis of surface topography of friction pair components was performed. The tribological tests were performed with used of a tribological instrument (tribotester T-24) in the Ringer's solution. The tribological characteristics as friction torque and worn surface of a polymeric component for two kinds of friction pair were obtained.

Measurement methods

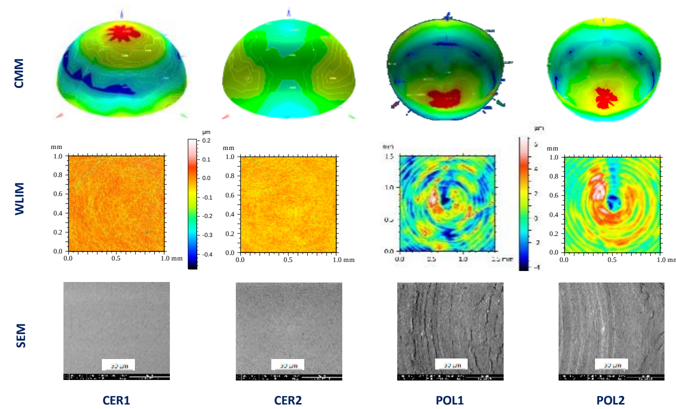


Tribometric studies (Tribotester T-24)

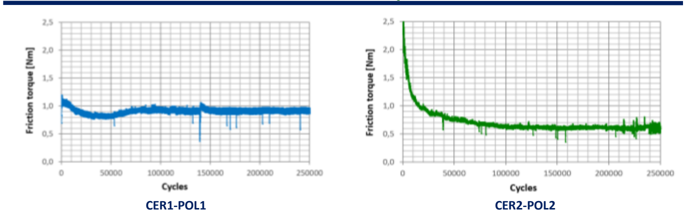
- Range of rotating-reversible motion -65 ÷ 65°
- Range of pendulum motion -25 ÷ 25°
- Rotation frequency 0.5 Hz
- Lubricant temperature 36.6 ± 0.5°C

RESULTS

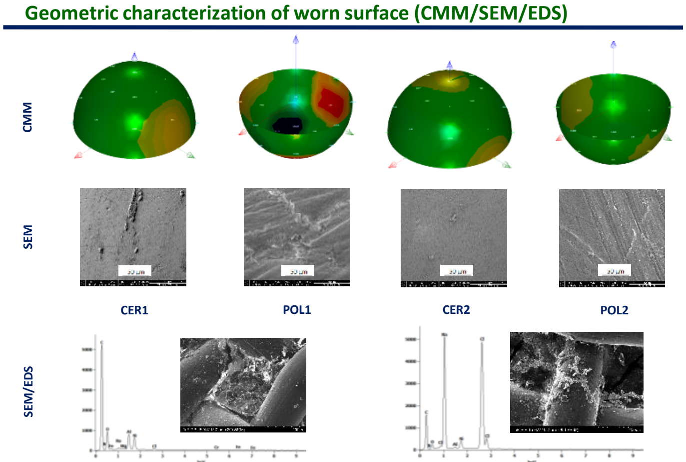
Geometric characterization of machined surface (CMM/WLIM/SEM)



Tribometric characterization – friction torque



Geometric characterization of worn surface (CMM/SEM/EDS)



CONCLUSIONS

There was a certain correlation between the machined surface established in the technological process, tribological characteristics, and the worn surface created during an operational process.

The surface topography of the ceramic parts (WLIM results) had a significant influence on the friction torque and wear of the polymeric parts. The wear products visible on ceramic surfaces and filters (SEM/EDS results) were the consequence of wear mechanisms, including plastic deformation, abrasive, fatigue and adhesive wear.

The combination of these two approaches (geometric and tribometric studies) showed that the best polimer acetabulum – ceramic femoral head friction pair, was the pair CER2-POL2.

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