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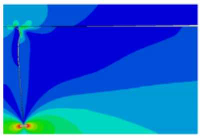

CHARACTERIZATION OF THE SURFACE TOPOGRAPHY OF THE WORN ARTIFICIAL HIP JOINT FRICTION PARTS BASED ON PARAMETRIC AND NON-PARAMETRIC DATA

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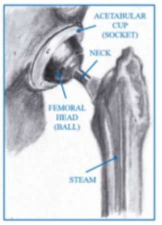
INTRODUCTION

Investigation of the surface topography and identifying wear mechanism of the hip joints after replacement, inside the human body (artificial hip joints) is impossible. Because the important point is to assess the lifespan of friction parts of the artificial hip joints, the main attention should be concentrated on investigating the surface topography of friction parts created in the operation process during in vitro studies.

This work presents issues of artificial hip joints and methods for characterizing the surface topography and wear mechanism of ball-and-socket friction parts (ceramic-polymer) at the subsequent stages of tribological tests.



MATERIALS AND MEASUREMENT METHODS

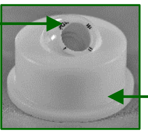
The subjects of studies and analysis were ceramic material used in conjunction with a polymeric material in friction parts of artificial hip joint: polymeric acetabulum (socket) and ceramic femoral head (ball).

The manufacturing process of both parts and tribological tests were performed in accordance with the guidelines of the standards ISO&ASTM.

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



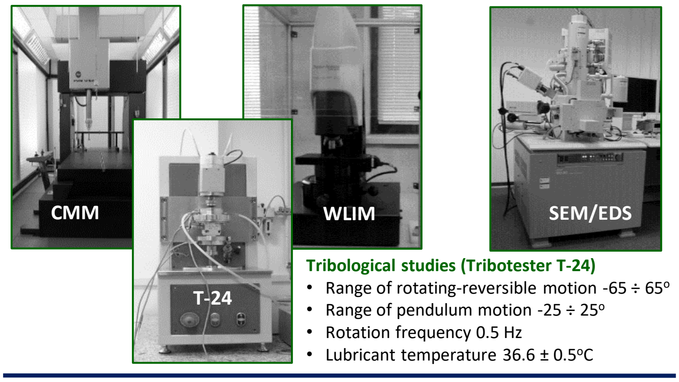
POL

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

The tribological studies were performed with used of a tribological instrument (tribotester T-24) in the Ringer's solution. The tribological characteristics and friction parts surfaces were obtained.

After each stage of tribological tests, the surface topography of friction parts was studied. For this purpose, two measurement instruments were used – a white light interference microscope WLIM and a scanning electron microscope SEM/EDS. In addition, the surface topography (sphericity) was examined before and after the operation process, using a coordinate measuring machine CMM. The multi-scale analyses of surface topography of friction parts were performed.

Measurement methods



Tribological 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

Based on the results (parametric and non-parametric data) the surface topography and wear mechanisms were characterized. The changes in surface topography were visible both, in values of parameters and views of surface morphology.

ACKNOWLEDGEMENTS

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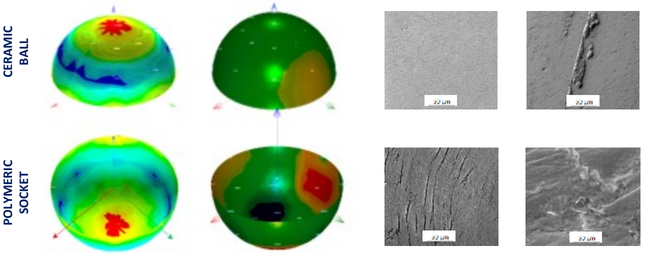
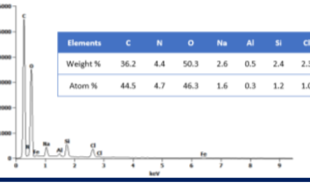
RESULTS

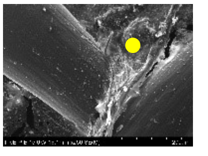
Machined and worn surface topography (CMM and SEM)



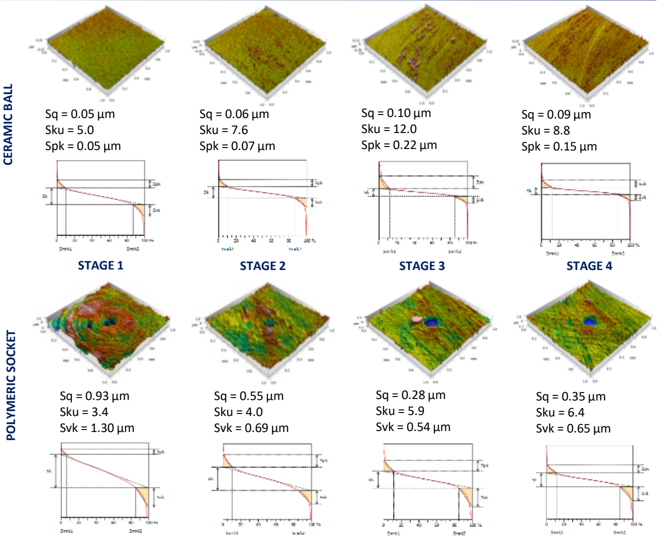
Wear products (SEM/EDS)



Elements	C	N	O	Na	Al	Si	Cl	K	Fe
Weight %	36.2	4.4	50.3	2.6	0.5	2.4	2.3	0.1	1.1
Atom %	44.5	4.7	46.3	1.6	0.3	1.2	1.0	0.0	0.3



Worn surface topography (WLIM)



CONCLUSIONS

The surface topography of the manufactured ceramic parts (CMM/WLIM/SEM results) had a significant influence on the tribological characteristics, including wear of the polymeric parts. The results of the worn surfaces were different for each stage of the tribological studies .

The wear products visible on ceramic surfaces and filters (SEM/EDS results) were the consequence of wear mechanisms, including plastic deformation as well as abrasive, fatigue and adhesive wear.

The non-parametric and parametric data allowed to describe the surface topography formed during operation process. It was shown that changes in the surface topography do not occur proportionally, but are various in time-varying. The wear of the polymer parts depends on the manufactured surface topography characterization of the ceramic parts.

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