ADDITIVE MANUFACTURING AS A POTENTIAL METHOD TO PRODUCE FRICTION SURFACES OF JOINT IMPLANTS: THE TRIBOLOGICAL BEHAVIOUR OF TI6AL4V

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KEYWORDS

- ***Biotribology; Mixed Lubrication; Texturation***
- ***3D printing of joint implants***

ABSTRACT

The number of joint replacements performed each year continues to increase [1]. Additive manufacturing (AM) is a current manufacturing method that is already finding its way into the production of artificial joints and could soon be more widely used than conventional manufacturing (CM). However, the long-term durability of artificial joints is still inadequate, especially for small joints such as the metatarsophalangeal joint of the big toe. The use of 3D printing allows for customisation and simplification of implant design, which can potentially improve their durability. In addition to these factors, it would also be possible to control the surface structure using 3D printing, which would make it possible to achieve texturing, which has already been shown to have a positive effect on the tribological behaviour of the contact pair.

This research compares the tribological behaviour of 3D printed Ti6Al4V with CoCrMo, the conventional and well-known material for joint implants. The experiments were carried out using a reciprocal tribometer with a pin-on-plate configuration. In addition to analysing the coefficient of friction and wear, we also studied the lubricant film using colorimetric interferometry to quantify its thickness and fluorescence microscopy to describe the behaviour of individual constituents of synovial fluid. The contact pair consisted of pins (see Fig. 1) made of CoCrMo (CM), Ti6Al4V (CM / AM) and textured Ti6Al4V (AM) and the counterpart made of glass, as one of the parts had to be transparent in order to observe the contact area using the optical method.

The initial research [2] indicated that a lubricant film thickness sufficient to separate the contact bodies for the Ti6Al4V alloy (CM) could not be achieved. Therefore, modifications to the friction surfaces were necessary. We attempted to create a surface structure using controlled 3D printing (see Fig. 1d), which was successful in locally increasing the thickness of the lubricant film (see Fig. 1f) and reducing the wear rate. The study demonstrates the feasibility of using 3D printing to create a surface texture with a positive impact on protein adhesion.

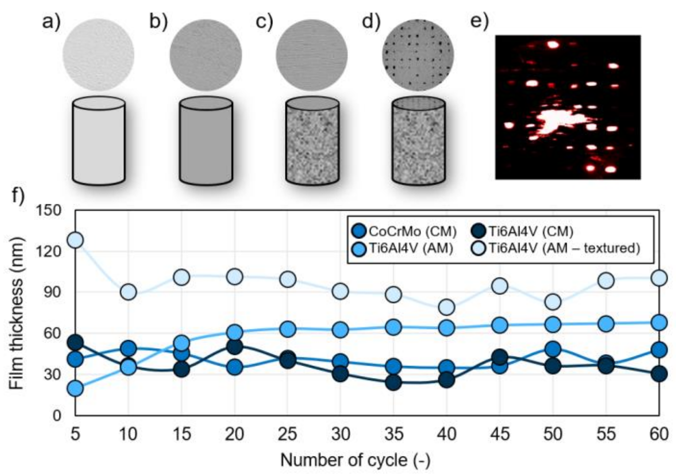

Fig. 1: Tested pins: a) CoCrMo (CM); b) Ti6Al4V (CM); c) Ti6Al4V (AM); d) Ti6Al4V (AM – textured); e) fluorescence microscopy of protein albumin; f) film thickness development.

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