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Creation Of Individual Intraosseous Structures Using Additive Technologies

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Introduction

In modern medicine, intraosseous constructions of various designs and functional purposes are used to restore lost organs and tissues. One of the main requirements for the materials from which implants are made is biocompatibility. Modern developments in the field of increasing biocompatibility are aimed at modifying the design of implants or the materials from which they are made, as well as applying bioactive coatings.It is impossible for medical personnel to identify all the advantages and disadvantages of designs from the proposed materials and coatings. Therefore, an urgent task is to create individual designs of intraosseous implants that can be used taking into account a particular clinical situation, which will significantly reduce complications during implantation at the stage of surgical treatment.

Methodology

An additive technology for the formation of implants based on the available three-dimensional models has been proposed, which involves the formation of products by sequential build-up of material, and not by removing excess material, as in traditional methods for manufacturing implants.

The technology includes (Fig. 1): 1. Powder preparation to obtain a metal-filled filament. Mixing of metal powder (70%), binder polymer (25%) and special additives (5%). 2. Mixing powders in a ball mill. 3. Filament extrusion with parallel heating of pellets. 4. Three-dimensional printing with metal-filled filament under the following technological conditions: layer height - 0.5 mm, maximum layer height - 0.8 mm, print speed - 10 mm/min, nozzle temperature - 230 °C, table heating temperature - 70 °C . 5. Removal of the binder by heating the product and holding for a certain time. 6. Sintering the product in a vacuum furnace.

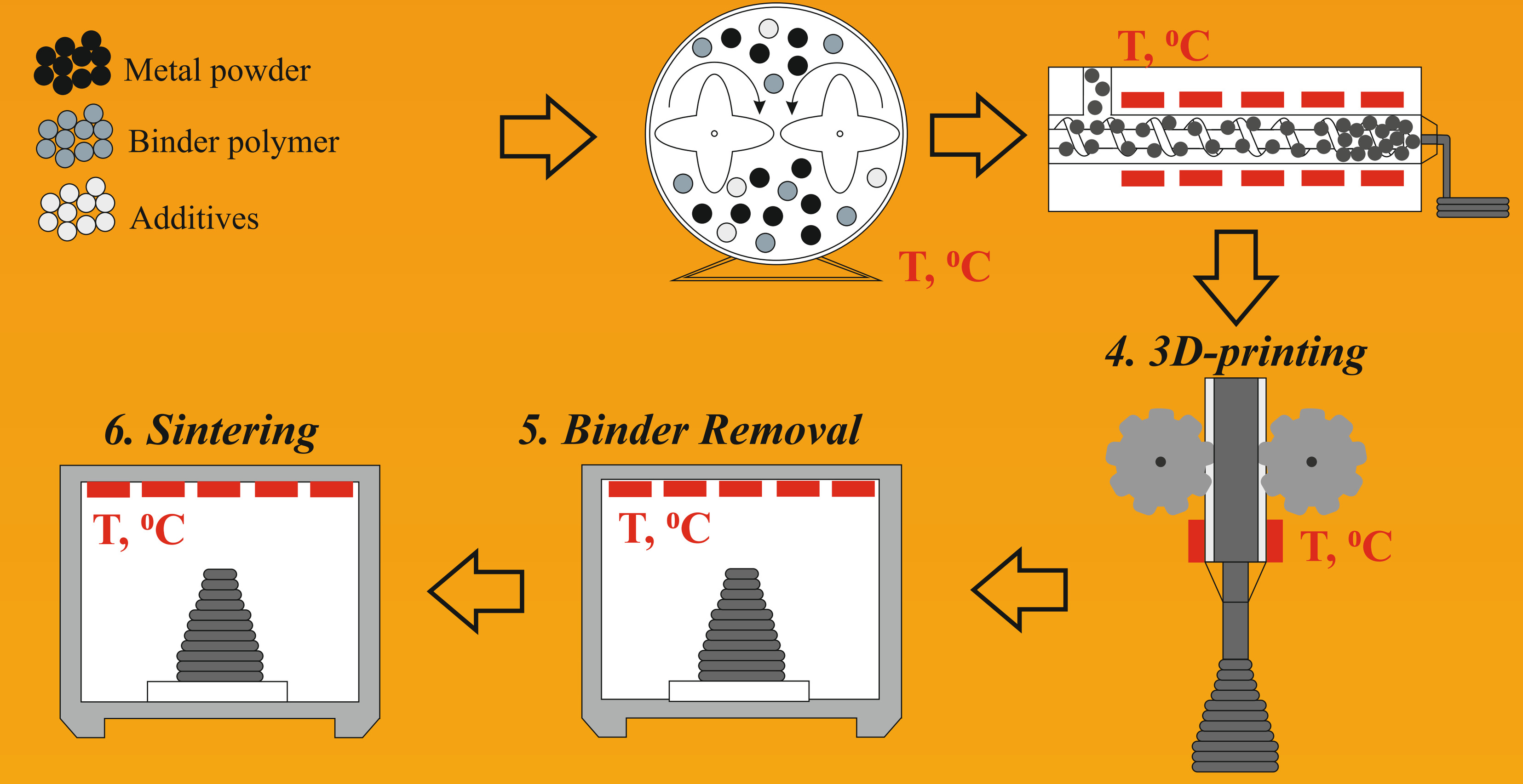
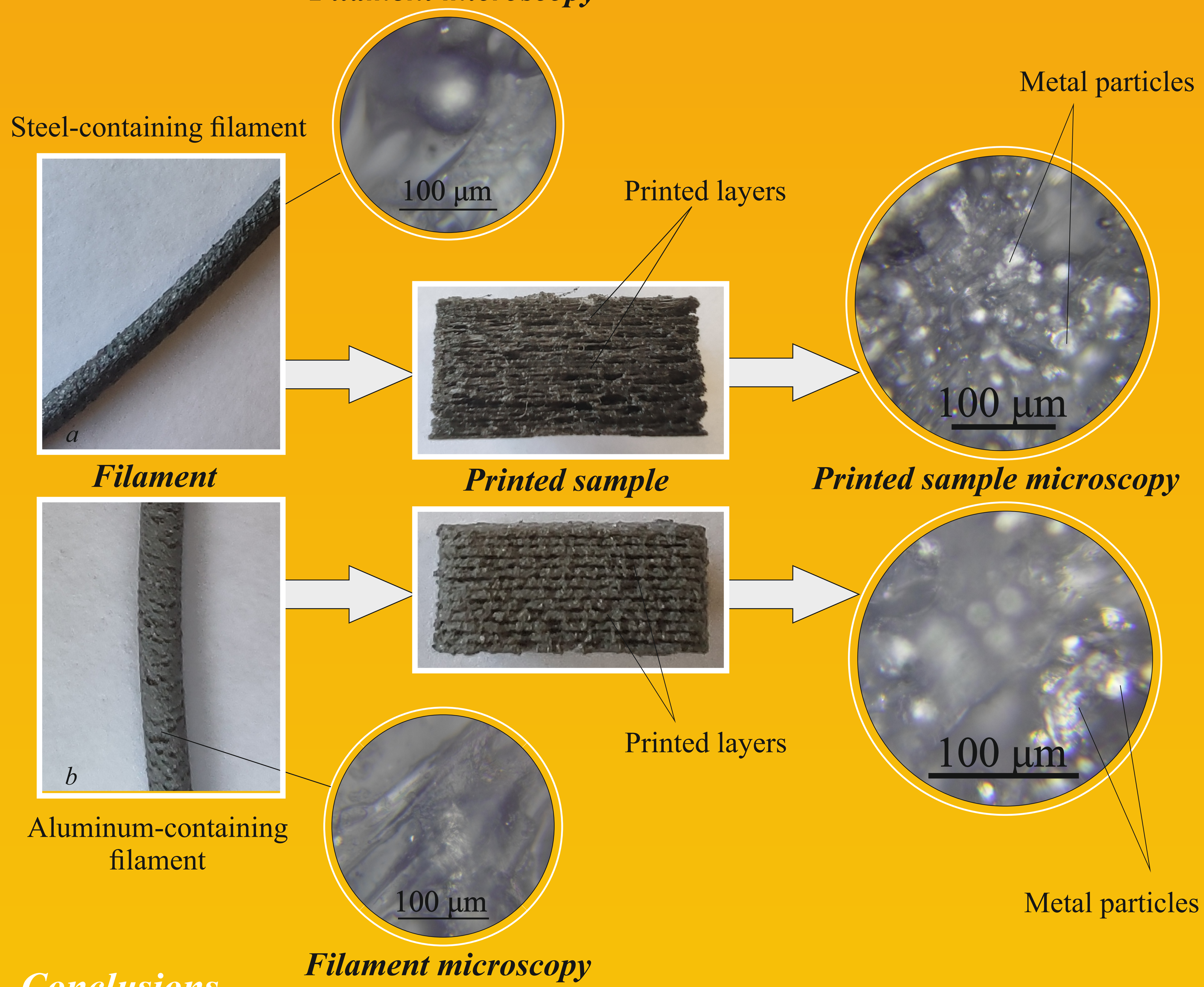


Fig. 1. Technology of additive manufacturing of intraosseous structures



Results

Filaments (Fig. 2) based on steel and aluminum powder mixed with PVA polymer were obtained by original methods. The study of the filament structure showed that it consists of long polymer threads with the inclusion of metal particles up to 40 µm in size.

An analysis of the surface of samples printed using a layer-by-layer 3D printer shows that when printing with aluminum filament, it is possible to create even layers without defects.

When printing with a filament with steel particles, there are areas with defects on the sample. In the layers of the formed samples, there are metal particles with a size of 20–40 µm, bound by a molten and solidified polymer. Metals are distributed evenly over the entire surface and occupy 40-50% of the sample volume.

Conclusions

An additive technology for 3D printing of implant structures based on a 3D model of a defect using a metal-filled filament is proposed. In the future, it is necessary to study in more detail the technology of heat treatment (sintering) of the obtained structures for various metals that make up the filaments. Relevant is the modification of the surface of the obtained structures using electrophysical and electrochemical methods.

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