Review of Rapid Prototyping Techniques for Tissue Engineering Scaffolds Fabrication

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Abstract:

Tissue engineering scaffold is a 3D construction that acts as a template for tissue regeneration. The scaffold should have some basic requirements including biocompatibility, suitable mechanical properties, appropriate surface chemistry, high porosity and interconnectivity. Although several conventional techniques such as solvent casting and gas forming are utilized in scaffold fabrication, these processes show poor interconnectivity and uncontrollable porosity of the produced scaffolds. However, Rapid Prototyping (RP) techniques which are a group of advanced manufacturing processes can produce custom made objects directly from computer data such as Computer Aided Design (CAD), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) data. Using RP fabrication techniques, constructions with controllable and complex internal architecture with appropriate mechanical properties can be achieved. The present chapter intends to provide an overview of the current state of the art in the area of tissue engineering scaffolds fabrication, using advanced RP processes. The present work highlights also the existing limitations in addition to future prospects in scaffold fabrication via RP techniques.

Keywords:

Tissue engineering  Scaffolding fabrication  Rapid prototyping  Solid free form fabrication  Biomanufacturing

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Polishing of fused deposition modeling products by hot air jet: Evaluation of surface roughness

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Abstract:

In this study, a novel low-cost polishing process is applied on the surface of Fused Deposition Modeling (FDM) products. The developed polishing technique impinges a jet of hot air exit from a nozzle to FDM surfaces. The hot air locally melts the staircase on the surface and leaves it smoother by the effect of sintering phenomenon. Accordingly, the process introduces three main parameters: air jet temperature; air jet velocity; and nozzle translational velocity over the part surface. An experimental test rig was constructed to evaluate the polishing process and its parameters using surfaces with average pre-processed Ra values of 7.5 ± 0.5 μm. The process shows significant and reproducible improvements in surface roughness inherent with a glossy surface; whereas, an average reduction ratio up to 88% was reached which corresponds to Ra of 0.85 μm. It was found that there is an allowable range of nozzle translational velocity for every combination between jet velocity and jet temperature; otherwise, lower nozzle velocity than allowable causes overheating and surface deterioration. Furthermore, the study presents in-depth investigation to these deterioration phenomena appeared on the surface. As a result, this investigation demonstrated the possible defects in FDM part surfaces and also evaluated different process parameters. Moreover, it was observed that surface defects are reduced in the polished surfaces. For a concise conclusion, it was found that the condition of low jet velocity and high jet temperature gives the best polishing result over the allowable nozzle velocities.

Keywords:

Fused deposition modeling Polishing Hot air Surface roughness Surface defects Sintering

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ENHANCING THE SURFACE ROUGHNESS OF FUSED DEPOSITION MODELING PRODUCTS

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Abstract:

Fused deposition modeling (FDM) is the most versatile additive manufacturing technology owing to the low-cost materials that handle. However, FDM produce very rough parts which limit its use in molds and other industrial applications owing to stair-case effect. To obtain smoother surfaces, a post-processing phase may be introduced. In this research, a non-contact finishing process to FDM parts using hot air was developed. The hot air is directed locally at the stair-case in the surface till melting it which results after cooling to a smoother surface. An experimental setup was constructed to study the effects of different process parameters including air temperature, air flow rate and the moving velocity of air nozzle over parts surface. An improvement in the Roughness Average of a surfaces measured microscopic peaks and valleys (Ra) down to values of sub-micron was recorded from specimens with average surface roughness from 7 to 8 μm.

Keywords:

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patient specific finite element modeling of human vertebra

Hend A Mostafa Osama AM Abdelaal Wael M Khier AA Khalil

Abstract:

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A new methodology for design and manufacturing of a customized silicone partial foot prosthesis using indirect additive manufacturing

Abdelaal O., Darwish S., Abd Elmougoud K., Aldahash S.

Abstract:

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Experimental investigation on the effect of water-silica slurry impacts on 3D-Printed polylactic acid

Osama Abdelaal, Mahmoud Heshmat, and Yasser Abdelrhman

Abstract:

The effect of water-silica slurry impacts on PolyLactic Acid (PLA) processed by Fused Deposition Modeling (FDM) under different conditions were investigated. The studied factors were building orientation, layer thickness, and slurry impact angle, where Taguchi design was used. The results showed an increase in the specimens' weights after the slurry erosion tests. This weight gain was eventually attributed to the synergistic effect of water absorption and the embedment of solid particles within the specimens. An analysis of variance (ANOVA) test was conducted and concluded that the layer thickness and impact angle are the significant factors influencing the weight gain resulting from absorbed water. Moreover, impact angle was the most significant factor for the weight gain resulting from embedded slurry particles.

Keywords:

Polylactic acid 3D printing Slurry erosion Regression

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Abstract:

Erosion and erosion-corrosion tests of as-built Ti-6Al-4V manufactured by Selective Laser Melting were investigated using slurries composed of SiO2 sand particles and either tap water (pure water) or 3.5% NaCl solution (artificial seawater). The microhardness value of selective laser melting (SLM)ed Ti-6Al-4V alloy increased as the impact angle increased. The synergistic effect of corrosion and erosion in seawater is always higher than erosion in pure water at all impact angles. The seawater environment caused the dissolution of vanadium oxide V2O5 on the surface of SLMed Ti-6Al-4V alloy due to the presence of Cl− ions in the seawater. These findings show lower microhardness values and high mass losses under the erosion-corrosion test compared to those under the erosion test at all impact angles.

Keywords:

selective laser melting (SLM); Ti-6Al-4V; slurry erosion; slurry erosion-corrosion; wear resistance; erosion mechanisms

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