Stereolithographic Additive Manufacturing of Bio-Ceramic Implants with Graded and Fluctuated Structures

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Biological ceramic implants exhibiting dendritic networks were fabricated by using stereolithographic additive manufacturing (STL-AM). Ordered porous geometries with graded and fluctuated arrangements were designed, manufactured and evaluated by computer aided methods (CAD/CAM/CAE). Biological fluid flows in artificial bones including geometric scaffolds were modulated effectively. In the lithography process, two dimensional (2D) cross sectional layers were created through photo polymerization by ultra violet laser drawing on a spread resin paste including ceramic nanoparticles, and three dimensional (3D) composite models were sterically fabricated through layer laminations with chemical bonding. A laser scanner with automatic collimator was newly equipped to realize precise micro pattering and high speed drawing by fine and thick beam spots, respectively. Photo sensitive acrylic resins with hydroxyapatite and β-tricalcium phosphate of 3 μm in particle diameter at 50 vol. % were spread on a glass substrate with 10 μm in layer thickness by a mechanical knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted from 10 to 100 μm in variable diameter and scanned on the pasted resin surface. Irradiation power was changed automatically from 10 to 200 mW to obtain enough solidification depth for layer by layer joining. Formed composite precursors were dewaxed and sintered under crystal phase transition temperatures to prevent loss of their biocompatibilities. Subsequently, ceramic implants were fabricated by a lithography process using high power ultra violet laser. The bio-ceramic particles were dispersed into the acrylic resin without photocuring functions to create the paste materials. The laser beam of 1W in irradiation power was scanned of the spread paste to dewax the resin and sinter the particles. The ceramic components were fabricated through the layer lamination and joining in ultra violet laser lithography (UVLL). Part accuracies of formed components were measured by using digital optical microscopy (DOM), and the ceramic microstructures were observed by using scanning electron microscopy (SEM). The centimeter order ceramic implants with the graded and micrometer order fluctuated patterns could be modulated systematically to realize vital fluid distributions and geometrical osteogenesis.