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Abstract

Directional Fabrication of Ceramic Components with Functional Geometries by Ultraviolet Laser Lithography

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Abstract:

Dielectric ceramic components with micro patterns were successfully fabricated by ultraviolet laser lithography. As an direct additive manufacturing, 2D cross sections were created through dewaxing and sintering by UV laser drawing on spread resin paste including ceramic nano-particles, and 3D composite models were sterically printed by layer laminations. As the row material of the lithography, ceramic nanoparticles from 500 nm in average diameters were dispersed in to photo sensitive liquid resins from 50 % in volume fraction. The resin paste was spread on a glass substrate at 50 μm in layer thickness by a mechanically moved knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted at 10 μm in spot diameter and scanned on the pasted resin surface. Irradiation power was increased at 700 mW for enough solidification depth for 2D layer bonding. The half wavelength of the incident ultraviolet ray should be comparable with the nanoparticles gaps in the resin paste, therefore the dewaxing and sintering will be realized through the electromagnetic waves resonations and localizations. Through the layer lamination, the 3D titania structures with 97% in volume fraction were successfully fabricated. The titania crystal structure was analyzed as dual phase of anatase and rutile. After the reheating treatment at 1350 °C for 2 hs, titania components with rutile phase was obtained. The linear shrinkage through the sintering was < 1 %. Dielectric constant and loss were measured as 100 and 0.3 at 0.02 THz in an electromagnetic wave frequency, respectively. The diamond lattice with four coordination number of 270 μm in periodicity could diffract electromagnetic waves of 0.25 to 0.45 THz, and exhibit forbidden gaps in transmission spectra for all spatial directions. The dielectric lattice especially call photonic crystal to open the electromagnetic band gap. Plane defects between the mirror symmetric lattice patterns of twinned crystals can resonate and localize the electromagnetic waves, therefore permission mode and transmission peaks were formed at 0.37 THz to in the electromagnetic bandgap.

Biography:

Soshu Kirihara is a doctor of engineering and a professor of Joining and Welding Research Institute (JWRI), Osaka University, Japan. In his main investigation "Materials Tectonics" for environmental improvements of "Geotechnology", multi-dimensional structures were successfully fabricated to modulate energy and materials flows effectively. Ceramic and metal components were fabricated directly by smart additive manufacturing, design and evaluation (Smart MADE) using high power ultraviolet laser lithography. Original stereolithography systems were developed, and new start-up company "SK-Fine" was established through academic-industrial collaboration.

Publication of speakers

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