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Abstract

Stereolithographic Additive Manufacturing on Ceramic Components with Modulated Dimensions

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Abstract:

In stereolithographic additive manufacturing (STL-AM), 2-D cross sections were created minutely through photo polymerization by UV laser drawing on spread resin paste including ceramic nanoparticles, and 3-D models were sterically printed by layer lamination. Designed models with intended 3-D structures were converted into the stereolithography file format through polyhedral approximations and sliced into a series of 2-D layers. The slicing pitches were defined as 50 µm for laser scanning stereolithography. The numerical data were transferred into each stereolithographic system to create raster patterns for laser scanning. The lithographic system has been developed to obtain bulky ceramic components with functional geometries. An automatic collimeter was newly equipped with the laser scanner to adjust beam diameter. Fine or coarse beams could realize high resolution or wide area drawings, respectively. As the row material of the 3-D printing, nanometer sized ceramic particles were dispersed in to acrylic liquid resins at 50 % in volume fraction. These materials were mixed and deformed to obtained thixotropic slurry for 15 min at 700 and 300 rpm of rotation and revolution speeds, respectively. The resin paste was spread on a glass substrate at 100 µm in layer thickness by a mechanically moved knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted from 10 to 300 µm in variable diameter and scanned on the pasted resin surface. Irradiation power was changed automatically from 10 to 200 mW. The created precursor was dewaxed and sintered in an air atmosphere to obtain full metal or ceramic components. Part accuracies of green bodies could be measured and observed by using a digital optical microscope. The microstructures of the sintered components were observed using a scanning electron microscope. Relative densities of these ceramic components were measured by the Archimedean method. Through computer aided smart additive manufacturing, design and evaluation (Smart MADE), solid electrolyte dendrites of yttria-stabilized zirconia with spatially ordered pores were processed for fuel cell miniaturization. Subsequently, ceramic sheets of lithium-lanthanum-titanate with micro emboss patterns were developed for all-solid batteries.

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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