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Oxygen concentration and conversion distributions in a layer-by-layer UV-cured film used as a simplified model of a 3D UV inkjet printing system

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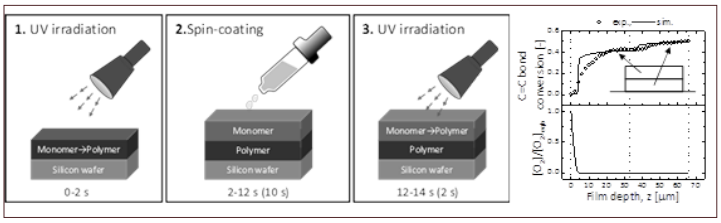
Three-dimensional (3D) ultraviolet (UV) inkjet printers represent a versatile technology for creating complex functional structures. During their operation, 3D objects are formed by repeating cycles of drawing a UV-curable resin with inkjet nozzles and then solidifying it with UV irradiation. In this study, the activity performed by a 3D UV inkjet printer was simulated by spin casting a 33 μm thick layer of UV-curable resin (containing diurethane dimethacrylate and 1-hydroxycyclohexyl phenyl ketone compounds mixed at a weight ratio of 99:1) onto a Si wafer followed by photo polymerization for 2 s at a UV irradiation of 10 mW cm^{-2}. Afterwards, the second resin layer with a thickness of 33 μm was spun-cast onto the first layer and photo-polymerized under the same conditions. The conversion distribution of C=C bonds in the UV-curable resin was investigated via confocal laser Raman microscopy and numerical calculations, which took into account the kinetics of photo-polymerization and oxygen inhibition reactions. The obtained experimental data were in good agreement with the results of numerical calculations, which attributed the existence of the two plateaus on the plot of the C=C bond conversion distribution to the formation of an oxygen-lean point. In addition, the effects of the UV intensity, irradiation time, lamination time, photo-initiator concentration, and concentration of dissolved oxygen on the oxygen concentration and conversion distributions across the depth direction have been examined. The obtained results revealed that the increases in the UV intensity, irradiation time, and photo-initiator concentration as well as the decrease in the initial dissolved oxygen concentration effectively increased the conversion of C=C bonds in the resin film and decreased the thickness of an un-polymerized layer.



Biography

Kentaro Takiame completed his PhD and became an Assistant Professor at Kyoto University, Japan. He is the Director of Advanced Reactive System lab, Kanazawa University, Japan. He has published more than 40 papers in reputed journals.

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