Shape recovery behavior of smart material specimens fabricated by additive manufacturing for 4D printing applications

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Abstract

The method of producing shapes through additive manufacturing is called 3D printing. There are various 3D printing methods, among which the material extrusion (ME) method is the most popular. The ME method also called the fused deposition modeling (FDM) method, is a method of melting filaments made of thermoplastics and stacking them through a nozzle.

When products are stacked using the ME method, the mechanical properties of the product appear differently depending on the deposition direction. Additionally, the mechanical properties of the product vary depending on the toolpath that the filament passes through on each layer. In ME type 3D printing, there are many studies on variations in mechanical properties depending on the direction of deposition and the movement path of the nozzle (toolpath). Since the morphology of stacked materials changes depending on the deposition direction and the toolpath, there is also researches to determine the relationship between mechanical properties and cross-sectional morphology.[1,2,3]

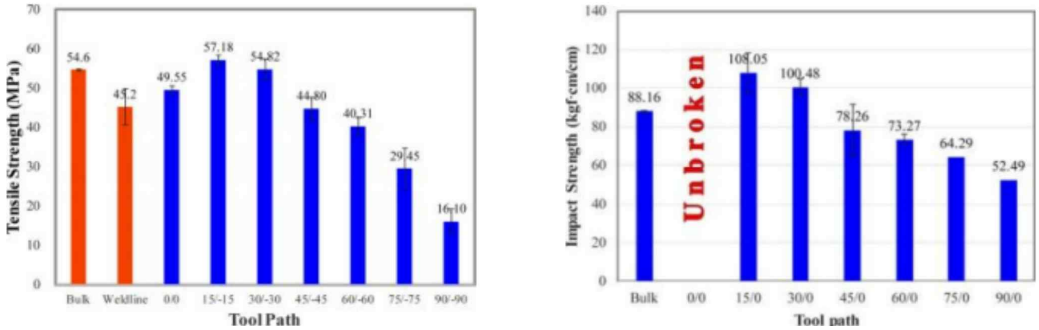

Figure 1. Variations of mechanical properties according to toolpath[2,3]

Materials that change their shape or properties in response to specific external stimuli are called smart materials. Producing a product through 3D printing using smart materials and changing its shape by applying a specific stimulus is called 4D printing. Just as the mechanical properties of the ME type 3D printed products vary depending on the deposition direction and toolpath, the degree of response to stimulation also varies depending on the deposition direction and toolpath in 4D printed products.[4,5,6]

In this study, specimens were manufactured through various toolpaths using shape memory polymer, a smart material, and the process of recovering the original shape by temperature stimulation was analyzed. We also observed changes in recovery ability when 4D printing-manufactured products were used repeatedly. Finally, the use of 4D printing produced in this study was introduced.

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