MCB, vol.16, supplemental 2, pp.74, 2019

Finite Element Analysis of 4D Printing

Kerlin P. Robert[1], Jiaoyan Li[2] and James D. Lee[1,*]

[1]Department of Mechanical and Aerospace Engineering, The George Washington University, Washington, DC 20052, USA.

[2]School of Engineering, Brown University, Providence, RI 02860, USA.

*Corresponding Author: James D. Lee. Email: jdlee@gwu.edu.

Abstract: This presentation focuses on the new and upcoming concept of 4D printing and its vast scope and importance in the research and development in industry. The 3D printing object is considered as a layered structure. Each layer may have different orientation. Therefore each layer may behave differently under the change of its environment. We formulate the theoretical shape changing process of 4D printing resulted from (I) the biological growth or swelling, (II) the change of temperature, and (III) the effect of electric field on piezoelectric material of the 3D printing product. Then we illustrate this theory visually through finite element analysis by solving several typical problems. Large strain is incorporated in the finite element formulation. We verify the finite element code through the conservation of the axis-symmetry or the mirror symmetry of the sample problems. This presentation demonstrates the capabilities and applicability of 4D printing.

Keywords: 4D printing; 3D printing; additive manufacturing; finite element analysis; biological growth; temperature variation; piezoelectricity; printing orientation; hyperelasticity; large strain

DOI: 10.32604/mcb.2019.07125