Preface for the Special Issue of 4D Printing

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4D printing is a concept that emerges recently as an innovative extension of 3D printing. Here, the fourth dimension refers time, i.e., the shape of a printed part can change over time and thus time becomes the fourth dimension in the shape forming process. 4D printing has the advantage of forming a complicated 3D shape from a relatively simple 2D or 3D shape, therefore saving printing time and materials.

A 4D printing is generally implemented by using multi-material 3D printing where one (or several) material(s) is a smart material. When the environmental condition changes, such as temperature is increased or the part is immersed in an aqueous environment, the response of the smart material drives the shape change of the printed part. The new shape (or 4D shape) is determined by how the smart material is placed spatially in the part, which could be very complicated and could be only implemented by 3D printing (easily). Here, it should be emphasized that the determination of where to place the smart material is the key in many designs for 4D printing. Therefore, some theoretical analyses are preferred.

In the past, shape memory polymers (SMPs) and hydrogels are the two most common smart materials used in 4D printing. The shape memory effect of a polymer can be achieved by using a thermomechanical loading around the transition temperature of the polymer. The polymer is first programmed (or fixed) into a temporary shape by heating, loading, then cooling; the original shape of the polymer can be recovered by heating it again. In 4D printing using SMP, the new shape of the printed part is typically formed by programming the SMP. In 4D printing using hydrogel, the swelling of the hydrogel in aqueous environment drives the shape change.

The field of 4D printing develops very fast since its emergence in 2013; however, there are still numerous challenges. For example, new smart materials are needed to expand the design and application scope; software development is needed; more applications should be explored, etc.

The papers in this special issue present some recent progresses and applications and discuss the recent research trend in the field of 4D printing. Below are the topics in this special issue;

- 4D Printing Using Different Printing Methods
- Design Aspects of 4D Printing
- Material Selection in 4D Printing
- Software Development for 4D Printing
- Soft Robot Applications of 4D Printing
- Potential Applications of 3D/4D Printing for Wearable Electronics and Smart Devices

This is the first attempt of the journal to publish a special issue focusing on emerging topics of manufacturing. We would like to express our sincere appreciation to all the authors as well as editorial members for their precious time and effort, and to Ms. Sung Gyung Lee of Korean Society for Precision Engineering (KSPE) for her dedicated support during the review and production processes.