4D printing using piezoelectric composite for medical applications

Abstract

Additive manufacturing, otherwise known as three-dimensional (3D) printing, is driving major innovations in many areas, such as engineering, manufacturing, art, education and medicine. Although a considerable amount of progress has been made in this field, there is still a lot of research work to be done in order to overcome the various challenges remained. Recently, one of the actively researched areas lies in the additive manufacturing of smart materials and structures. The goal of the PhD concern the developpement of material for 4D printing, and the application of this technology for healthcare.

Introduction & goal of the PhD

Recent advances in materials and manufacturing have the potential to enable fabrication of smart structures and complex systems. In the past, it has been difficult for conventional materials to achieve simultaneous improvement in multiple functions. However, with increasing use of composite materials, the potential to make more complex functional systems is being extended. These systems can carry many functions, such as electrical and thermal conductors, plasmonics, energy storage, self-healing, sensors, actuators, biocompatibility and biodegradability, etc. Previously, three-dimensional (3D) printing has primarily been used to generate replicas of natural and man-made structures, such as bioimplants, toys, art statues, structural metallic components, etc.. Besides, over the past few years, the number of materials manufactured by 3D printing has increased by a large extent. One category of materials that has been in the spotlight recently is the smart materials. One important type of smart material that has been used widely is the piezoelectric material that is able to produce electrical charge or voltage when experiencing an externally applied stress and vice versa.

Different categories of piezoelectric materials offer different capabilities. Piezoelectric ceramic have been historical used of the realization of different type of transducer, but the main challenge for additive manufacturing is the high temperature required during the sintering, which is not compatible with typical materiel used in 3D printing based on polymer with low melting point, ie 150°C to 250°C. The others class of material is the piezoelectric polymeric materials i.e. PVDF family. These materials are suitable for systems that require mechanical flexibility, small active elements. However, it is still a difficult task to fabricate piezoelectric polymeric materials into complex 3D structures. Since PVDF need to be stretched during the procedure of polymerization or problem of adhesion between piezoelectric element and other material and also cost in case of copolymer family. The most restrictive aspect of ferroelectric polymers is the high electric fields required to reach their macroscopic piezoelectric properties. To overcome these different issues, this study is focused on the fabrication of inorganic-organic composite for additivite manufacturing. One goal of the PhD concern the development of piezoelectric composite using commonly polymer matrix in additive manufacturing by insertion of ferroelectrics particles. The second part concern the application of the smart material for heathcare application.

PhD profile

We search PhD-student with open mind, that able to work on different field (material, electrical, mechanical, applied physics) and in collaboration with team of surgeron.

Key words: 4D printing, smart material, mechatronic, additivite mechatronic, sensor

PhD supervisors

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