"4D PRINTING TECHNOLOGY"

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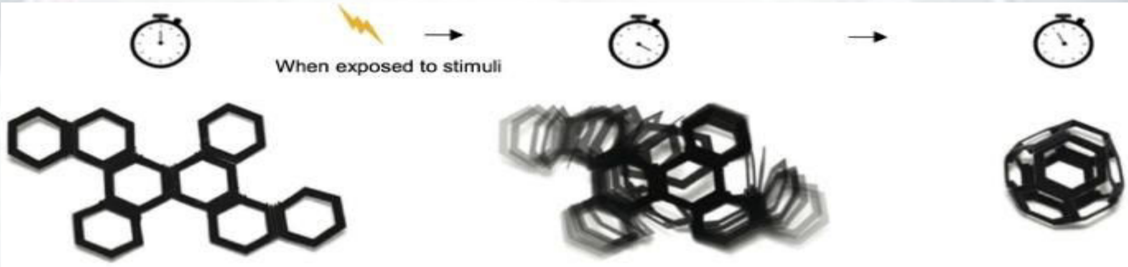
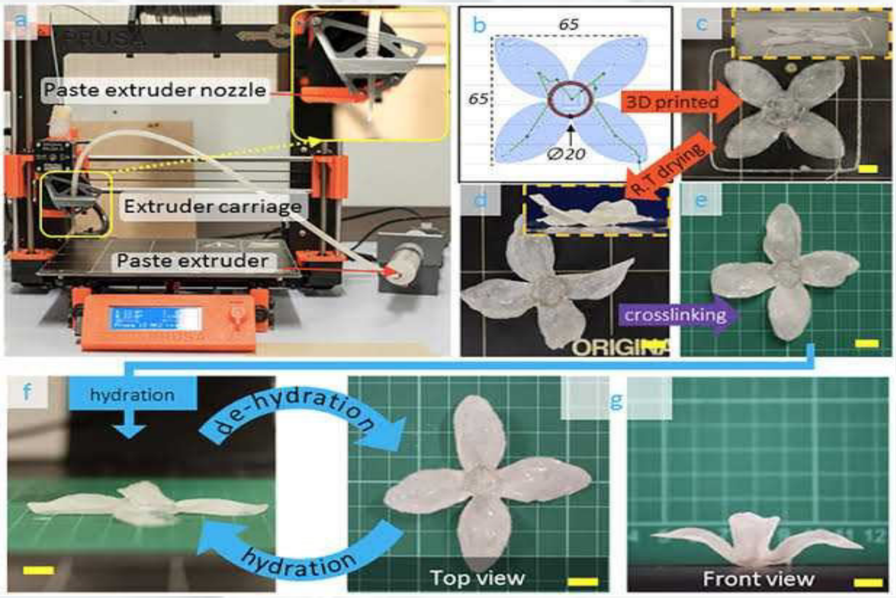
SE Mechanical (2020-21)

4D printing is also known as 4D bio-printing or shape changing systems. It uses the same techniques of 3D printing (Adaptive Manufacturing) through computer-programmed deposition of material in successive layers to create a three-dimensional object. However, 4D printing adds the dimension of renovation over time.



It is therefore a type of programmable matter; wherein after the fabrication process, the printed product reacts with parameters within the environment (i.e. water, humidity, temperature, wind, etc.,) and changes its form accordingly. The ability to do so arises from the near infinite configurations at a micrometre resolution, creating solids with engineered molecular spatial distributions and thus allowing unprecedented multifunctional



4D printing is a relatively new advance in bio fabrication technology, rapidly emerging as a new model in disciplines such as materials science, bioengineering, chemistry, and computer sciences.

Stereo lithography is a 3D-printing technique that uses photo polymerization to bind sub-strate that has been laid layer upon layer, creating a polymeric network. As opposed to fused deposition modelling, where the extruded material hardens immediately to form layers, 4D printing is fundamentally based in stereo lithography, where in most cases ul-traviolet light is used to cure the layered materials after the printing process has complet-ed. Anisotropy is vital in engineering the direction and magnitude of transformations un-der a given condition, by arranging the micro materials in a way so that there is an em-bedded directionality to the finished print.

4D printing helps to achieve rapid and accurate manufacturing methods for controlling spatial self-bending actuation in custom-designed soft structures. Spatial and temporal transformations can be realized through several actuation mechanisms such as liquid crystal gel phase transition, thermal expansion coefficient, thermal conductivity discrep-ancies, and the different swelling and de-swelling ratios of bi-layer or composite beams.

One approach to model 4D printing is to control 3D-printing parameters, such as differ-ent spatial patterns of hinges affecting the response time and bending angle of the 4D print products. A parametric model of physical properties of shape memory polymer panes incorporating 3D printed patterns was developed to that end.

The proposed model predicts the final shape of the actuator with an excellent qualitative agreement with experimental studies. These validated results can guide the design of functional pattern-driven 4D printings.