



4D PRINTING SRP & SMP



01-2021

Additive Manufacturing Digital to Physical



4D Printing: A technology coming from the future

M. Young, ALL3DP Company, 2016.

Additive Manufacturing

4D PRINTING OF STIMULI-RESPONSIVE AND SHAPE MEMORY POLYMERS USING THE FFF TECHNOLOGY

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In the last few years four-dimensional (4D) printing technologies have attained growing worldwide interest and they are considered the "next big thing". The aim of this presentation is to provide three examples of stimuli-responsive polymer (SRP) applications additively manufactured (AM) by the fused filament fabrication (FFF) technique and two examples of PLA based shape memory polymer (SMP) applications. A CCT BLUE filament of thermo-responsive polymer was chosen to produce a water temperature indicator, which changes the color when the temperature is increased; a CCU RED filament of photo-responsive polymer was used to produce a sunlight / UV indicator bracelet; a transparent PLA CLEAR polymer, a CCU RED photo-responsive polymer, and an electrically conductive PLA polymer were selected to produce a business card stand. A PLA based filament of eSUN SMP was used to print two preliminary applications: a spring and a vase. We trust that these examples will help to increase the interest in FFF 4D printed stimuli-responsive polymers and shape memory polymers possible applications. Much R&D remains to be done in designing the objects and develop the FFF printing parameters taking advantage of SRPs and SMPs being developed for this technology.

Let's Start with 2D Printing (ADOBE)



Digital to Physical





Overview of Additive Manufacturing

> Additive Manufacturing process



ECONOMICS OF AM



AM – GE - FUEL NOZZLE



Additive Manufacturing



In his 2013 TED Talk (TED stands for technology, entertainment, and design), Skylar Tibbits, the co-director of the MIT Self-Assembly Lab and a pioneer of 4D printing, demonstrated how 3D-printed materials can adapt to their surroundings (water, in his example)



FUSED DEPOSITION MODELING









WAYS TO ACTIVATION OF SRPS

* Light induced SRPs

- * Thermal responsive SRPs
- * Electrical induced SRPs
- Magnetically induced SRPs
- Ultrasound activated SRPs
- Water/Solvent activated SRPs



intense sun light

low sun light





6 °C 12 °C 14 °C 16 °C 9 °C 18 °C 22 °C 25 °C 29 °C 32 °C 36 °C 20 °C 30 mm R G B





Graphite based Conductive Polymer

Graphite ~10-5 ρ (Ω •m)









(a)

(b)

SPLINT - SUPPORT FOR A BROKEN BONE WHILE IT HEALS

Synergy3DMed

- טכנולוגיה FDM
- (Stratasys) M30I ABS חומר
 - זמן הדפסה 14 שעות
- מדפסת Stratasys Fortus 450mc •



סד יד : תעלות למוליכים פסים מחליפי צבע במגע עם היד

SN

Amelon

Esun

~36C

SHAPE MEMORY POLYMERS (SMPS)





SHAPE -MEMORY POLYMERS (SMPS)



SHAPE MEMORY POLYMERS (SMPS)

SHAPE MEMORY POLYMER





• SMPeSUN 4D filament e4D-1 white (Esun Industrial Co., Ltd) filament diameter 1.75 mm, and spool weight of 0.5 kg.



FUSED DEPOSITION MODELING (MP)

SHAPE MEMORY POLYMER (MECHANICAL PROPERTIES)



SHAPE MEMORY POLYMER







SHAPE MEMORY POLYMER



(c)





(d)

(f)





ECONOMICS OF AM





https://www.asme.org/engineering-topics/media/aerospace-defense/video-printinghigh-performance-fuel-nozzle. Photo credit: GE Aviation



Thank you for your attention!

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