3D Printing Presentation

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3D Printing

What is 3D Printing?

1. Prints a given design on a software in the form of a three-dimensional object.
2. Relies on 2-D printed slices and combines them for the 3D appeal.
3. 3 common methods of 3D printing:
    - #1: Chemicals that turn solid after UV laser used→ laser moves across thin liquid and moves onto second layer & as layers complete the laser solidifies the design.
    - #2: Molten ink that turns solid when leaving the head of the printer→ follows the layer by layer then solidified process.
    - #3: Powdered material creates layered design that is held together with heat and glue and further translated to the design.

3D Printing (continued)

1. By definition and in Chuck Hall's (inventor) words, the printer prints ultraviolet curable materials and stacks them onto each other to create the design.
2. Ultraviolet curable materials are polymerized in short amounts of time (time efficiency) and are industrial materials for sealing, bonding, and coating.
3. Used to create affordable models and prototypes
4. Materials used in 3D printing: ABS/*PLA Plastic (flexible and durable plastic, cheapest materials for 3D printing), Nylon (white powder material similar to plastic, can be dyed and polished), Powder Material (fuses together by heat from laser and finishing product doesn't need welding or machining, → strong material on its own)

Advantages of 3D Printing

There are several advantages to 3D printing:

#1. **Speed**
- Rapid prototyping

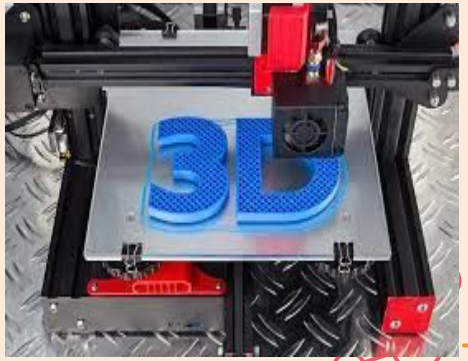
#2. **Cost**
- CNC milling and injection require several expensive machines→ only 1 or 2 machines required for 3D printing

#3. **Flexibility**
- Barely any change to the physical machinery after printing, in contrast to traditional methods
- Slicer software and precise geometries

#4. **Quality**
- Step-by-step assembly→ enhances strength in design

#5. **Consistency**
- Slices are monitored
- Printed in succession

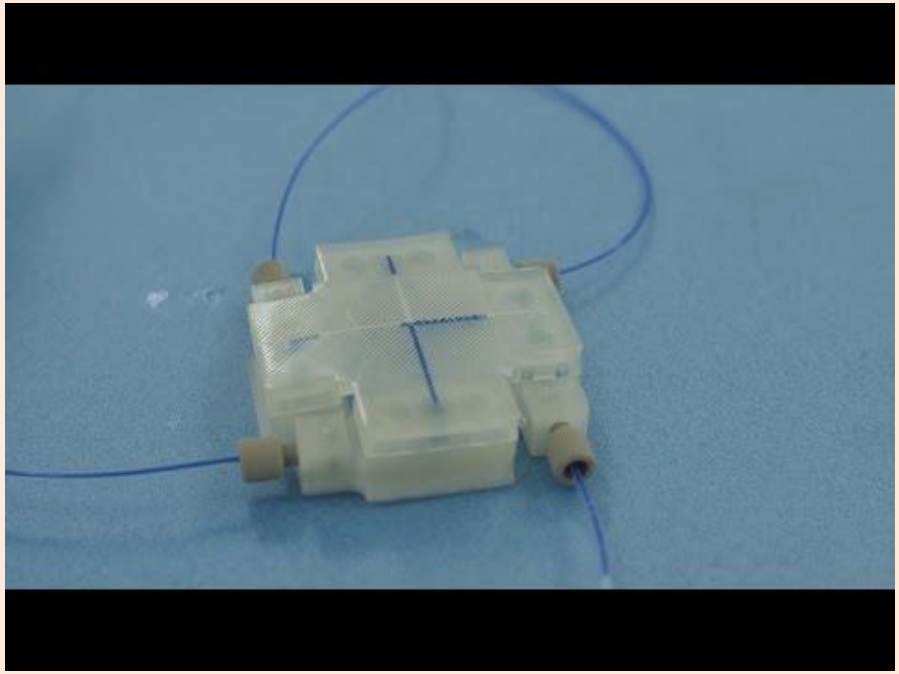
#6. **Accessibility & Sustainability**
- Completely automated → no extra supervision
- Setup is cost efficient
- Creates a lot of waste less material→ recyclable



3D Printed Microfluidics

- Put ABS in uncured PDMS, cure it and dissolve ABS with acetone → makes intricate microfluidics
- Fluids behave differently at a microscale, which allows for targeted experiments
- Example need for capsules:
  - Nuclear fusion→ capsules for placing nuclear fuel
  - Protocells→ studying membrane-protein interactions
  - Encapsulation of stem-cells→ repair spinal cords
- 3D printing allows to make microfluidics rapidly
  - Iterating, designing, changing rapidly
  - Affordability
- You don't need much skill, solely know how to design on a computer
- Potential drawback: leaking. Counterargument: print slowly and in thin layers for transparency and watertight(gaps lose transparency)
- 3D printing allows you to transfer designs and ger results more simply and accessibility → access the benefits of microfluidics.

Recapp of 3D Printed Microfluidics



PDMS ink printing

1. A tradition 3D printer cannot use a random form of ink, rather has to use solid powder or liquid ink.
2. Modeling can only be achieved by certain materials, such as molten plastic.
3. It is desirable to 3D print with PDMS → “3D printing of PDMS improves its mechanical and cell adhesion properties”
    - PDMS bioprinting ink is achieved by blending siloxane polymers (SE 1700 and Sylgard 184)
        - SE 1700: High viscosity (thickness from internal friction) polymer that gives ink shape fidelity
        - Sylgard 184: Lower viscosity that strengthens the ability of the ink
    - Printed shapes had objects to test the PDMS ink to span empty spaces and create pore spaces in solid blocks. The shapes tested the shape fidelity after curing.
    - PDMS coheres to plates to support the structure of the shape and contributions to menial shape deformation.
    - Hollow structures showed the ability to be created within the PDMS structure and are used to pattern cell and tissue construct.
    - Lattice structures tested PDMS ink length span over empty spaces
4. PDMS in 3D printing can allow for mass production and can reduce the time of traditional tooling methods

3D Printed Microfluidics

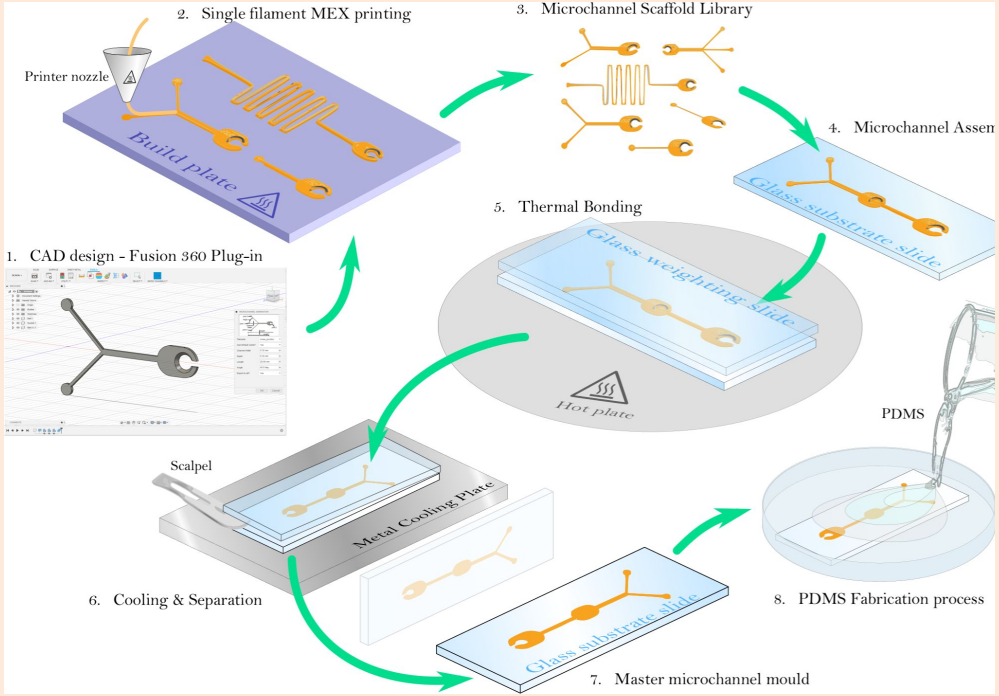
-University of Bristol has developed a novel low-cost and open-source 3D printing process for producing microfluidic devices

- Standard desktop 3D printer and in free-to-use software→ researchers' process reduces the cost and complexity
- Rapid prototyping of affordable LOC diagnostic technology possible at the point-of-care (POC).

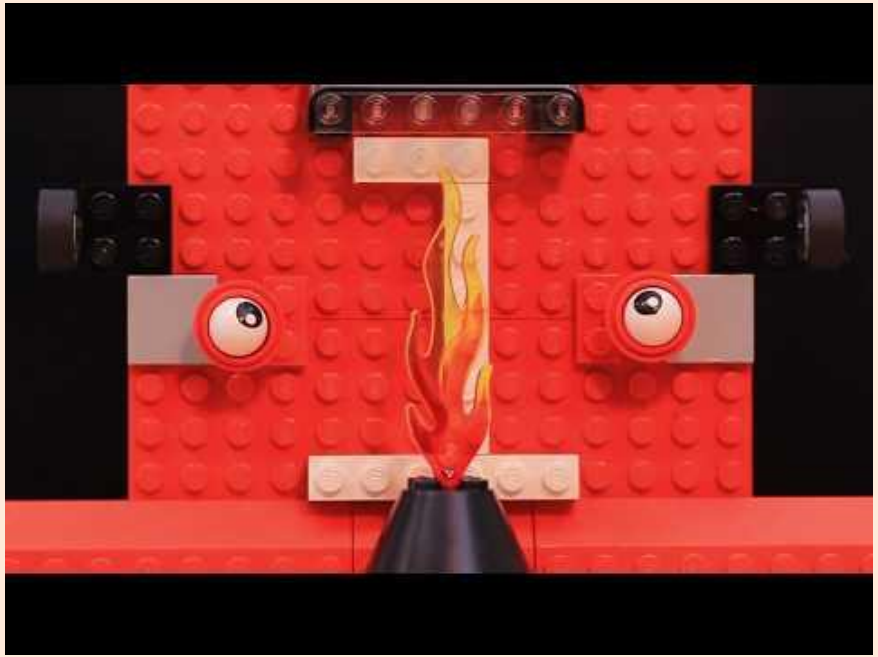
-LOC technologies are supported by microfluidics and are expanding to 3D printing techniques to advance the technology and accessibility.

-New York Genome Center and New York University made open-source 3D printed droplet microfluidic control instrument → 200 times cheaper than comparable instruments.

-UC Davis used new approach to 3D printing using microfluidics (droplet-based microfluidic system) to 3D print finely-tuned flexible materials


2. Single filament MEX printing
Printer nozzle
Build plate
3. Microchannel Scaffold Library
4. Microchannel Assen
Glass substrate slide
5. Thermal Bonding
Glass weighting slide
Hot plate
1. CAD design - Fusion 360 Plug-in
PDMS
Scalpel
Metal Cooling Plate
6. Cooling & Separation
8. PDMS Fabrication process
Glass substrate slide
7. Master microchannel mould

3D printed microfluidic chips in 2 mins



Sources

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