

Fused Deposition Modeling and 3D Printing

Subjects: [Pharmacology & Pharmacy](#)

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The operating principle of 3D printing is the layer-by-layer fabrication of objects, using a digital design. Before printing, a 3D digital model of the object is created with a computer-aided design (CAD) software, offering the ability of designing various complex final structures. The structure is then “sliced” in 2D layers which are printed one by one, on top of each other, in order to finally afford the 3D object. Stereolithography, which is based on the selective photo-polymerization of a liquid resin, was the first technique developed for 3D printing technology. Two other methods have mainly been employed for printing polysaccharides: fused deposition modeling (FDM), mostly for cellulose and its derivatives, owing to the good processing window between their glass transition temperature and the onset of thermal degradation temperature; and extrusion-based printing, which is appropriate for hydrogels.

fused deposition modeling

3D printing

extrusion

1. Fused Deposition Modeling (FDM)

Fused deposition modeling is a 3D printing technology that uses a continuous filament of a thermoplastic material for the fabrication of complete structures (**Figure 1**) ^{[1][2][3][4]}. The utmost advantage of FDM is the preparation of many shapes in a short time, with a low cost in comparison to traditional manufacturing processes ^[5]. FDM was developed by S. Scott Crump in the late 1980s and was commercialized in the early 1990s by (Stratasys Inc., Edina, MN, USA) ^[6]. Its setup is typically composed of a printhead freely movable in X and Y directions, a Z direction movable platform and a raw material in a cylindrical-shaped filament. The printhead consists of a heated nozzle where the polymer is softened/melted and laid down onto the platform as a layer according to the CAD design, where it cools down and hardens ^[7]. The following layers are deposited on top of the already printed layers and they then fuse with them, building the object in a bottom-up approach, while all the movements of the head and the raw materials are controlled by a computer.

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