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3D Printing for Tumor-on-a-Chip Component Fabrication

NANOTECHNOLOGIES
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INTRODUCTION

Tumor-on-a-chip (ToC) devices use microfluidics to replicate tumor features in controlled environments, enabling studies in tumor biology and therapies. Unlike traditional models, ToC can better mimic intricate tumor microenvironments and microarchitectures. They offer accuracy, scalability, and integration of multiple cell types, extracellular matrix, oxygen and nutrient gradients and proper mechanical forces (e.g. fluid flow, shear stress). A comprehensive tumor-on-a-chip device comprises cells, microenvironment, microfluidic device, sensors, and actuators, forming a dynamic model for in-depth tumor research. This work focuses on the fabrication of a TOC microfluidic structure by 3D printing, a cost-effective and efficient alternative tool for wide-spread use of TOC technology.

METHODS

Conventional methods like photolithography offer high precision but come with high costs and complexity. In this study, a 3D printed ToC shell was produced. The design incorporates 200 µm circular microfluidic channels perpendicular to a cylindrical culture chamber (2 mm diameter, 1 mm height) (Fig. 1a). The initial master was produced on an LCD printer (Anycubic Photon) with standard UV-sensitive resin. The design was replicated on a Polyjet printer (Stratasys Objet 30) with VeroClear resin. Needles with 200 µm were inserted as master to define the channels, covered with PMMA (polymethylmethacrylate) to enable injection of 10:1 PDMS (polydimethylsiloxane). The PDMS mold was cured at 80 °C for 1 hour, ensuring structural integrity. A microCT scan evaluated the dimensions of the printed part.

RESULTS

- LCD printed masters (Fig.1b) exhibited photoinitiator interference with PDMS curing. A pre-treatment of 20 min UV + 1 h @ 80 °C was necessary to eliminate inhibitors.
- Polyjet printed masters showcased successful PDMS curing.
- Both masters (Fig.1c) yielded well-defined microfluidic structures.

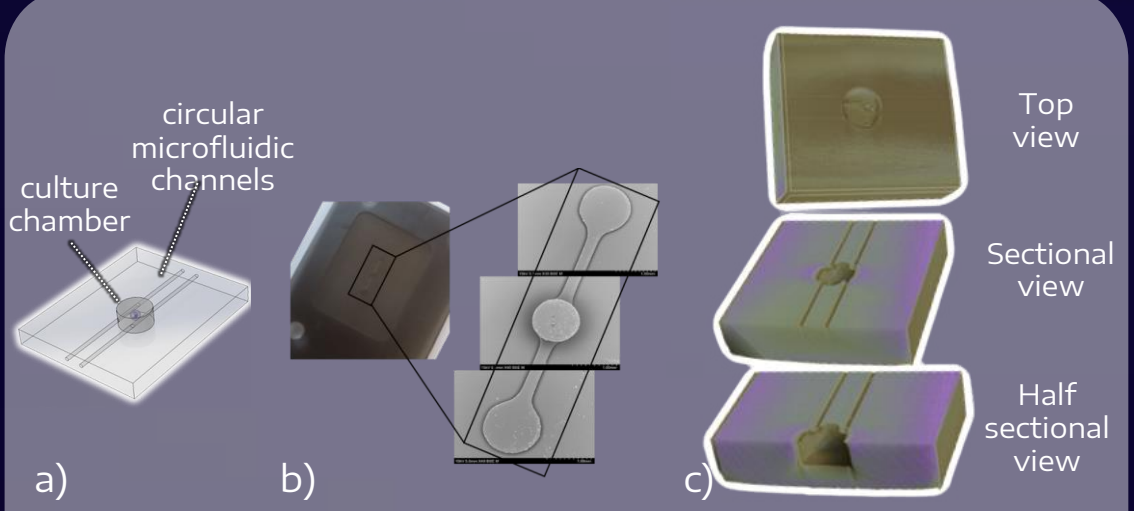

Fig.1 a) ToC CAD; b) SEM images of a LCD printed master; c) and multiple microCT scans of the final PDMS ToC shell

CONCLUSION

3D printed masters exhibit rapid prototyping, design flexibility, cost-effectiveness, scalability, and accessibility. Despite resolution and material limitations when compared to traditional methods, they provide a viable alternative for efficient tumor-on-a-chip fabrication in scientific research.

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