Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2023, Vol. 5, No 1, Suppl. 1, Article ID 799, 1 Page

Infinite Science Publishing

Abstract

Inkjet printing of poly(ethylene glycol) diacrylate for a hybrid 3D printing process

A. Sannan[1*], R. Mau[1], T. Eickner[2], M. Teske[2], N. Grabow[2] and H. Seitz[1]

[1] *Chair of Microfluidics, University of Rostock, Rostock, Germany*
[2] *Institute for Biomedical Engineering, University Medical Center Rostock, Rostock, Germany*
[*] *Corresponding author, email: ahmed.sannan@uni-rostock.de*

Drug delivery systems (DDS) play an important role in modern medicine. Medication can be tailored to the individual patient with the help of DDS. In this way, less amounts of the drug are required, and side effects can be reduced. A hybrid 3D printing process that combines micro-stereolithography (µSLA) and inkjet printing can be used to produce DDS. In this process, µSLA is used to build the DDS. An inkjet printhead is applied to incorporate a drug solution during the assembly process to create a specific drug depot [1]. To analyze the suitability of poly(ethylene glycol) diacrylate (PEGDA) as a drug carrier for realizing drug depots, the inkjet printability of PEGDA was investigated in this work.

PEGDA with a molecular mass of 250 g/mol (PEGDA250) was inkjet printed using a Nanoplotter 2.1, equipped with a piezoelectric printhead NanoTip HV-J-H (GeSiM mbh, Radeberg, Germany). Since PEGDA250 has a viscosity of about 20 mPas at room temperature, measured with the Haake Mars II rheometer (Thermo Fisher Scientific Inc., Waltham, Massachusetts, USA), printability is limited with typical inkjet printheads, which are usually optimized for lower viscosities (about 5-10 mPas). In this study, we investigated the inkjet printability of PEGDA250 using a NanoTip HV-J-H printhead, which can process fluids with higher viscosities of ~ 20 mPas and provides a heater for viscosity adjustment of the printed fluid. PEGDA250 was inkjet printed using different printhead voltages and printhead temperatures. The size and trajectory of the ejected main and satellite droplets were analyzed using a stroboscopic imaging system integrated into the Nanoplotter.

With an unheated printhead (T = 20 °C) and a moderately heated printhead (T = 38 °C), reproducible droplet formation with a droplet volume of ~ 300-500 pl was achieved at printhead voltages in the range of 60 V to 80 V. If the printhead temperature was further increased to T = 60 °C and T = 80 °C, the printability of the ink decreased as the viscosity of PEGDA250 decreased sharply. At T = 80 °C almost no droplet formation was possible anymore.

It has been shown that PEGDA250 can be inkjet printed with a high viscosity printhead with no or moderate heating. It is thus suitable as a base material for drug loading and for realizing drug depots in a new hybrid 3D printing process. In the next steps, drug depots with incorporated drug-PEGDA solutions can be produced and analyzed with respect to a defined drug delivery.

AUTHOR'S STATEMENT

Conflict of interest: Authors state no conflict of interest. Research funding: The authors would like to thank the Federal Ministry for Economic Affairs and Energy (BMWi) for the funding, references: KK5037210RU1, KK5364801RU1

REFERENCES

[1] J. Konasch et al., "A Novel Hybrid Additive Manufacturing Process for Drug Delivery Systems with Locally Incorporated Drug Depots," *Pharmaceutics*, vol. 11, no. 12, p. 661, 2019

DOI: 10.18416/AMMM.2023.2309799