Research paper

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PII: S0939-6411(17)31529-1
DOI: https://doi.org/10.1016/j.ejpb.2018.03.006
Reference: EJPB 12723

To appear in: *European Journal of Pharmaceutics and Biopharmaceutics*

Received Date: 28 December 2017
Revised Date: 11 March 2018
Accepted Date: 14 March 2018

Please cite this article as: T. Shpigel, A. Uziel, D.Y. Lewitus, Sphrint – Printing of Drug Delivery Microspheres from Polymeric Melt, *European Journal of Pharmaceutics and Biopharmaceutics* (2018), doi: https://doi.org/10.1016/j.ejpb.2018.03.006

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Abstract

This paper describes a simple, straightforward, and rapid method for producing microspheres from molten polymers by merely printing them in an inkjet-like manner onto a superoleophobic surface. Similar to 3D printing, a polymer melt is deposited onto a surface; however, in contrast to 2D or 3D printing, the surface is not wetted (i.e. exhibiting high contact angles with liquids, above 150°, due to its low surface energy), resulting in the formation of discrete spherical microspheres. In this study, microspheres were printed using polycaprolactone and poly(lactic-co-glycolic acid) loaded with a model active pharmaceutical ingredient—ibuprofen (IBU). The formation of microspheres was captured by high-speed imaging and was found to involve several physical phenomena characterized by dimensionless numbers, including the thinning and breakup of highly viscous, weakly elastic filaments, which are first to be described in pure polymer melts. The resulting IBU-loaded microspheres had higher sphericity, reproducible sizes and shapes, and superior drug encapsulation efficiencies with a distinctly high process yield (>95%) as compared to the conservative solvent-based methods used presently. Furthermore, the microspheres showed sustained release profiles.

Keywords: Sphrint, printing, polymer, melt, superoleophobic surface, microspheres, drug delivery