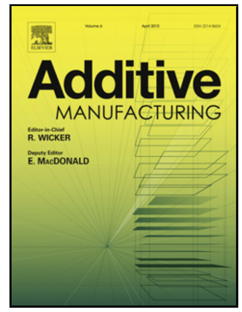

Title: Adaptive Stitching for Meso-Scale Printing with Two-Photon Lithography.

Author: S. Dehaeck B. Scheid P. Lambert

PII: S2214-8604(17)30576-6
DOI: https://doi.org/doi:10.1016/j.addma.2018.03.026
Reference: ADDMA 322

To appear in:

Received date: 6-12-2017
Revised date: 27-3-2018
Accepted date: 28-3-2018

Adaptive Stitching for Meso-Scale Printing with Two-Photon Lithography.

S. Dehaeck[a,*], B. Scheid[a], P. Lambert[a]

[a] *Université Libre de Bruxelles (ULB), TIPs (Transfers, Interfaces and Processes), CP165/67, Avenue F. D. Roosevelt 50, 1050 Brussels, Belgium*

Abstract

An inevitable trade-off between resolution and total size exists when 3D printing objects. This is also the case for Two-Photon or Multi-Photon lithography. While it is capable of reaching a sub-micron feature size, it needs to combine a high precision movement mechanism with a lower precision one when writing centrimetric size objects. As a result, the final part consists of a combination of many individual blocks, where the overlapping areas often create bumps and imperfections in the final object. In the current contribution, we demonstrate how an adaptive stitching algorithm can lead to a reduction in the total amount of stitching blocks of up to 40% for slender objects (i.e. with features smaller than the individual block size). As is demonstrated on a winding microfluidic channel, this can lead to substantial manufacturing time gains of up to 25%. As our tiling is irregular, we also explain how to create the writing masks for the blocks and decide on their order. In the special case in which one does not need to print one single large continuous part, but rather many individual ones (such as a microlens array), we demonstrate how a zero-overlap stitching can be achieved with a modified version of our adaptive algorithm.

Keywords: 3D-printing, stitching, two-photon lithography, meso-scale, microfluidics, microlens array

1. Introduction

3D printing is slowly taking over many manufacturing processes, in part due to its capability of simplifying the construction of complex items, which otherwise require many sequential processing steps. Even relatively new manufacturing methods, such as the creation of microfluidic chips by photo-lithography, are already under scrutiny as evidenced by recent reviews (e.g. [1, 2]) and as demonstrated in e.g. [3, 4]. One of the identified advantages of 3D printers is their capability to integrate macro-scaled pumps or connectors directly into the chip (e.g. [5, 6]). Another advantage is that it can remove the need for expensive and laborious mask-alignment machines to create simplified 3D shapes. Such simplified layered shapes still hold value as they typically can be easily replicated to PDMS, the gold standard in microfluidics. Note that the use of 3D printers in this respect can be seen as an upgrade to other Direct Laser Writing (DLW) machines (e.g. [7], Heidelberg DLW 4000 or Kloe-Dilase). While the afore-mentioned DLW machines are also capable of creating some height variations by the use of gray-scale lithography, these height variations typically remain very small (e.g. ±12µm in [8]) with respect to the range that is possible with a true 3D printer (e.g. Kloe-Dilase 3D, Nanoscribe Photonics Professional, Autodesk Ember, ...).

However, one of the current issues identified, which limits the current widespread implementation of 3D printers for microfluidics, is the limited resolution of Fused Filament Fabrication printers and even Stereo-

*Corresponding author
Email address: sam.dehaeck@gmail.com (S. Dehaeck)