Research description

Molecular Design of High Quality 3D Printing Materials

Introduction

The main asset of 3D printing is the almost unlimited designer freedom. 3D printing can be performed with a variety of materials and different deposition techniques. Some spectacular results in 3D printing have been achieved in the art, medical and industrial domains. 3D bio-printing has already been used for the generation and transplantation of several tissues, including multilayered skin, bone, and heart tissue. Defense manufacturer Aerojet Rocketdyne introduced a small, 3D printed rocket engine. These successes, however, are mainly obtained with living biological materials or metals in applications with a high added value. On the other hand, using polymers for printing results in low quality products at a slow production rate.

Quality issues and production speed are met with all current polymer 3D print technologies but are most prominent in Fused Deposition Modelling. This technology is used most often for home printers. In Fused Deposition Modelling a string (filament) of material is supplied to an extrusion nozzle head. The nozzle head, which can be moved in all directions, heats the material and deposits the molten material layer by layer.

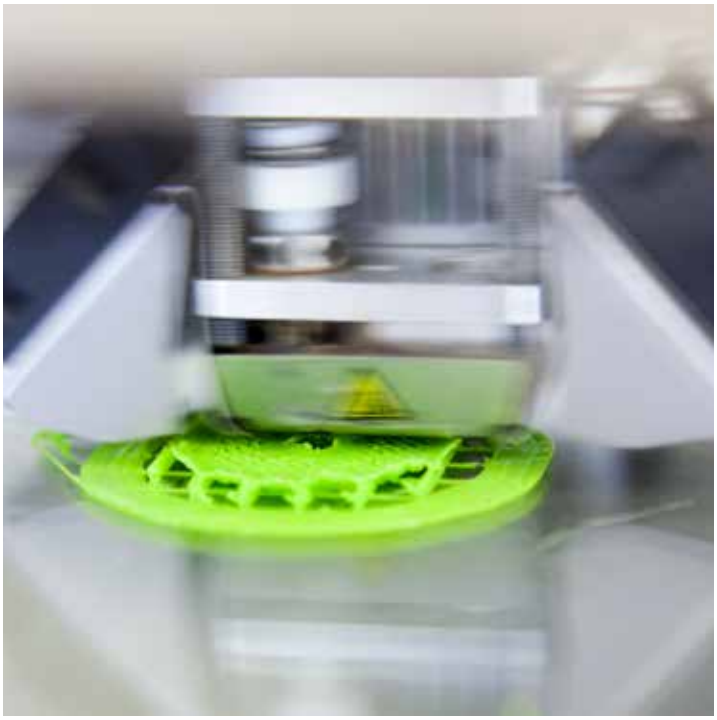
Research Centre for Material Sciences

The aim of the Research Centre Material Sciences is to facilitate sustainable innovative research and development in the field of polymeric materials; connecting innovation and learning.

Focus in our research is on three key technologies: MicroReactor Technology, Nano Technology and 3D Printing Materials.

Partner of
Chemelot Innovation and Learning Labs

NEW CONNECTIONS - NEW SOLUTIONS



Zuyd Research

ZUYD

foto's: Han Dols fotografie

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Grant
- Limburg Economic Development
- SIA Raak Pro

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Research partners
- Maastricht University
- Fontys
- CHILL
- 3D Ultimaker
- API
- Xilloc Medical
- DSM
- Corbion Purac

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Websites
www.microreactortechnology.eu
www.zuyd.nl/onderzoek/lectoraten/material-sciences

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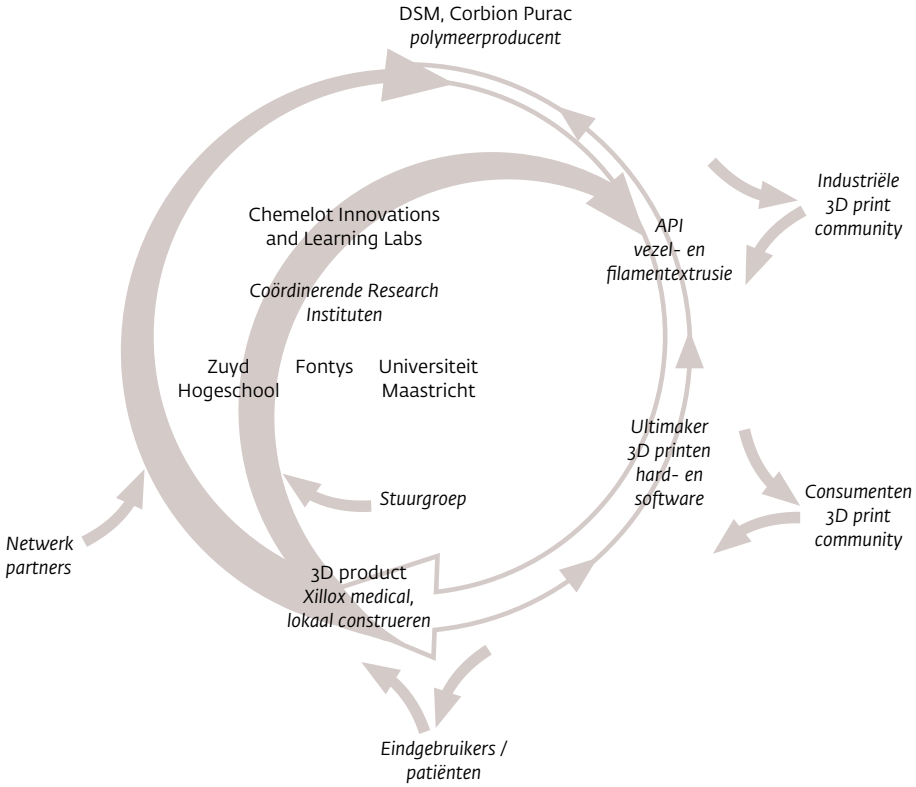

Since the material has to solidify fast, the molecules are more or less frozen in a random orientation. Especially for large polymers this means that they do not have the time to entangle with the next layer. This results in a layered structure with welds and inherent mechanical weakness.

In the "frozen" state there is still some mobility. Driven by intramolecular interactions the molecules will use this mobility to get organized in lower energetic state and possibly crystallize. In the crystalline state, however, the molecules occupy a different amount of space thus leading to the loss of shape in time. For polylactide acid, one of the most used (biobased) polymers in Fused Deposition Modelling, this process can take up to months.

Objectives

The current class of polymers used are not developed and optimized for 3D printing. To improve the performance of polymers in Fused Deposition Modelling, dedicated research is needed. To this end Brightlands Chemelot Campus, University of Maastricht, LIOF, Fablab Maastricht, CHILL and the Zuyd Research Centre for Material Sciences started the Additive Manufacturing Materials Centre with financial support from Limburg Economic Development. The main goal of this centre is to develop new, good performing materials for 3D print applications.

Project

A consortium of Zuyd, Maastricht University, Fontys, CHILL, 3D printer developer and producer Ultimaker, API an applied polymer research institute and Xilloc Medical a developer and producer of implants in collaboration with plastic suppliers DSM and Corbion Purac started a project on the molecular design of quality materials for 3D printing. An application for financial support from SIA is submitted.

Results

The focus of this project is to get insight in the effect of molecular structure, molecular weight, molecular weight distribution, nucleating agents, blends etc. on the properties (e.g. crystallization rate) of plastics and their performance in Fused Deposition Modelling. The use of secondary (supramolecular) interactions between molecules will be explored to avoid the mechanical weakness between the layers of a printed product.

Grant
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Research Partners