Institute for Chemical Technology of Organic Materials

JOHANNES KEPLER UNIVERSITY LINZ

DIGITAL MATERIALS FOR 3D PRINTING

Development of novel inks for 3D-PolyJet printing

http://www.jku.at/cto/

http://www.dimap-project.eu/

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Introduction

The DIMAP project focuses on the development of novel ink materials for 3D-PolyJet printing. The goal of this specific sub project is to produce a light weight ink system which is foamable during printing. Foam, a structure made up of a solid, stable compound and a gaseous compound, has one major advantage over solid compounds: it has a very low density combined with high structural robustness. This weight reduction combined with the mechanical properties makes this material a very interesting candidate for 3D-printing. Therefore, the chosen way in DIMAP to fulfil the material requirements for light weight polymeric materials is to directly print polymeric foams. [1,2]

To ensure a successful outcome, the work effort is split into two experimental setups: utilizing thermally expandable microspheres (TEMs) and generating an open cell foam (OCF). TEMs are synthesized with a core of physical or chemical blowing agent, so that upon energy input, the outer shell will be expanded and a porous lightweight structure can be established (Figure 1). In the OCF approach the blowing agent is dispersed in the ink matrix and upon adding energy decomposes or evaporates and therefore creating the foam structure.

Results

Principle experiments have been conducted to realize a proof of concept for the different synthesis routes. This has been achieved for the microsphere approach with physical blowing agents and the OCF approach with chemical blowing agents. TEMs syntheses were conducted with different parameter variations and were carried out as free radical oil in water suspension polymerizations via a known polymerization route.[3] Although the particle size of the produced TEMs is still too large to be used in the current printer and printhead setup, this proof of concept will be used as a basis for further advancement of the TEMs synthesis. TEMs in the state of expansion can be seen in Figure 2.

Development of a suitable foaming and curing procedure is an important part of the printing process, as it defines the structure and stability of the printed foam. The curing procedure consists of 3 steps: short low-power UV-irradiation to increase the ink viscosity, foaming of embedded CSP and short high-power UV-irradiation to fully cure the matrix in order to stabilize the formed foam structure. Figure 3 shows the curing degree of a possible matrix material for the light weight polymeric ink during UV-polymerization.

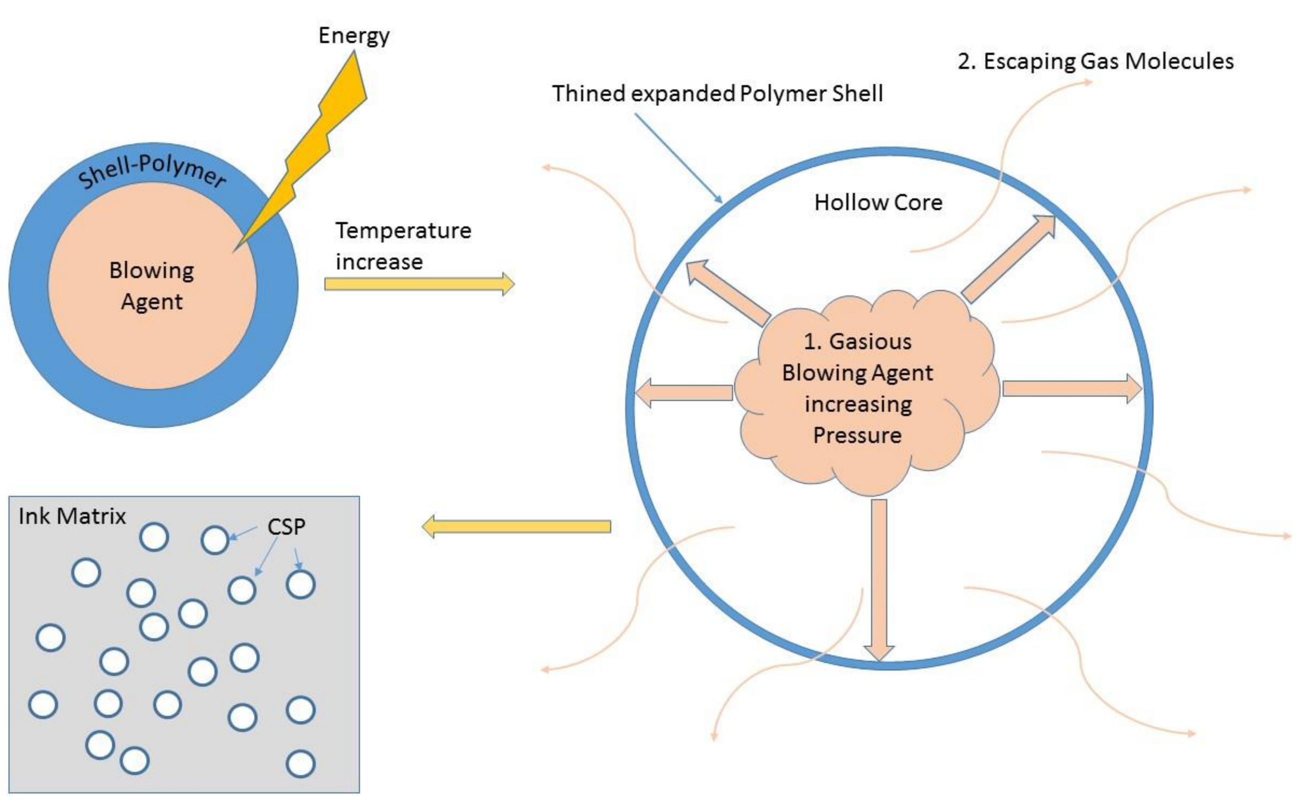

Figure 1: Principle of foaming with TEMs

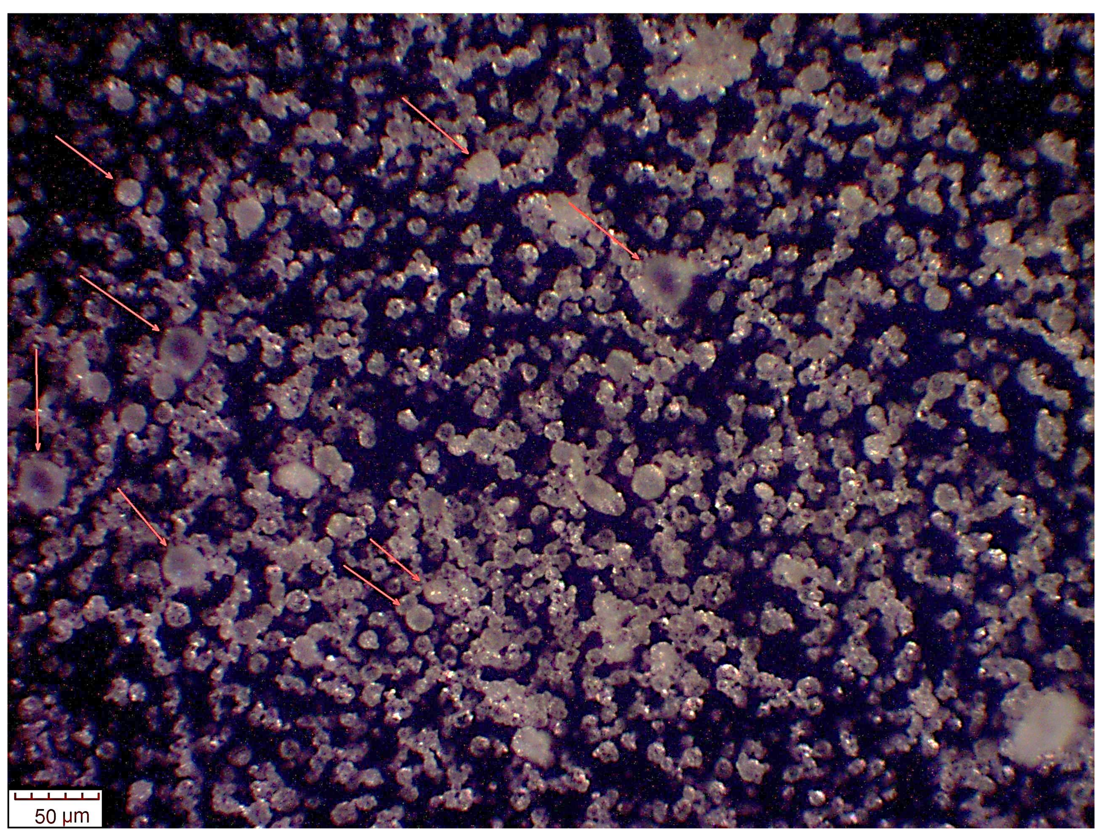

Figure 2: TEMs during expansion

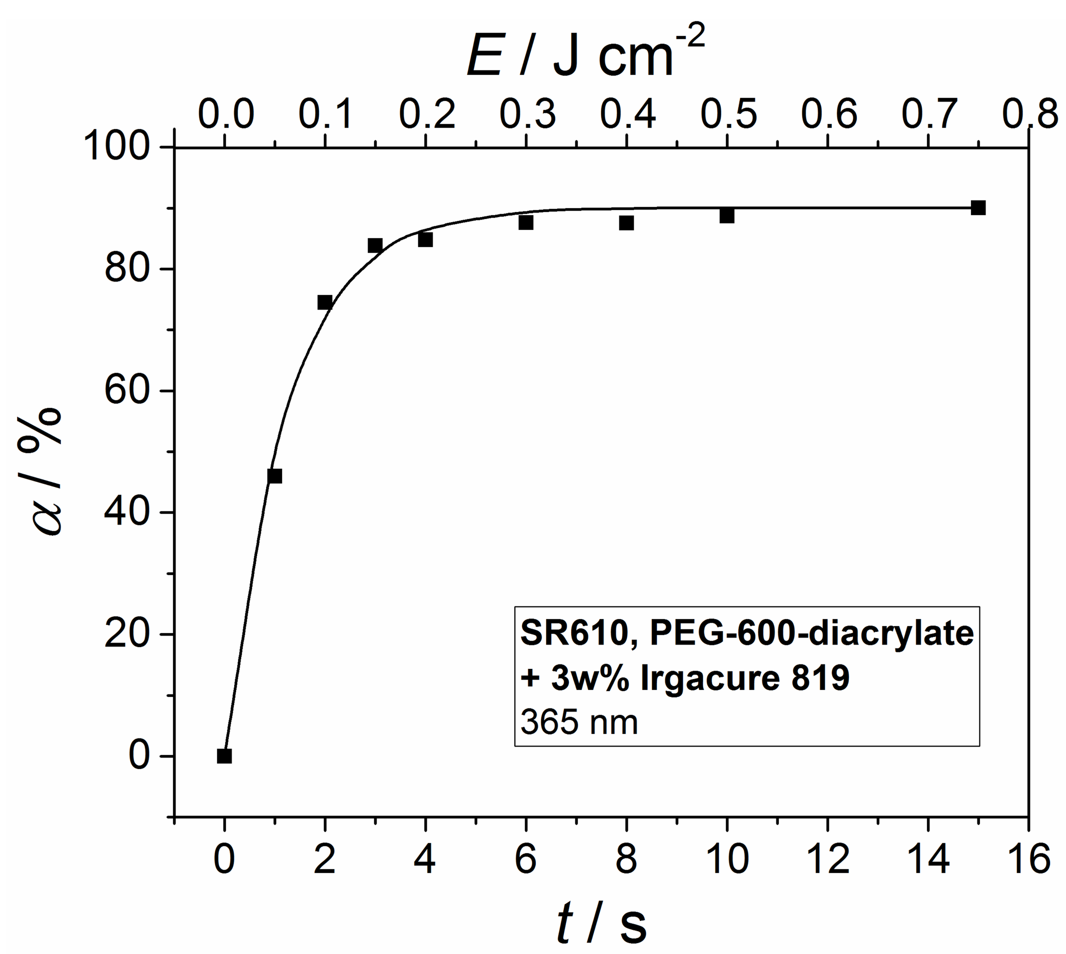

Figure 3: Curing degree of ink matrix material

Conclusion and Outlook

With a proven principle of synthesis, the focus now lies in the size reduction of the thermally expandable microspheres, as well as the development of appropriate ink additives for stabilization. A suitable curing and foaming procedure for different ink systems will be developed to receive high weight reduction together with good stability of the final printed foam structure. Different analytical methods, e.g. SEM and AFM, will be used to characterize the produced foam structures.

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