# Thermally-triggered Directed Assembly of Microparticles for 3D Printing


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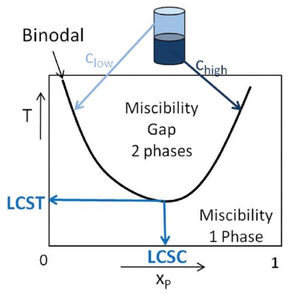
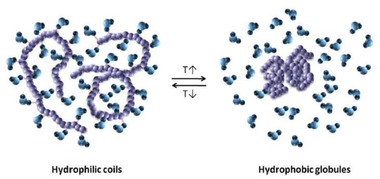
## Abstract

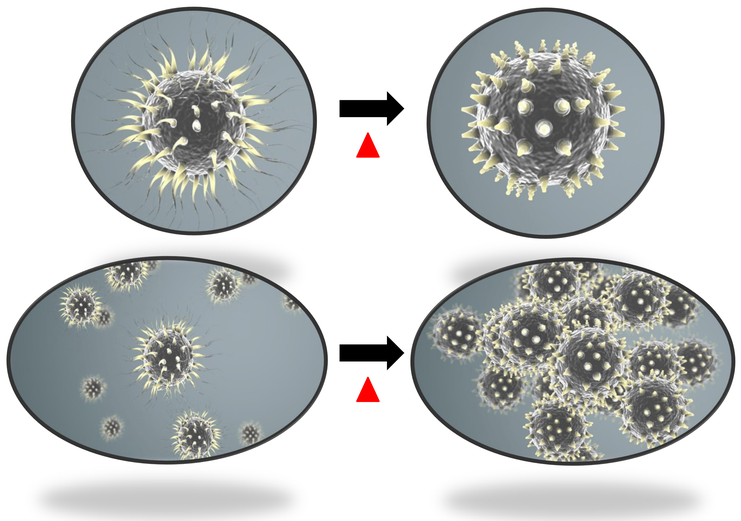
The extra cellular matrix (ECM) of human tissue possesses complex and heterogeneous structures. There is a need for engineered materials to meet the unique requirements of tissue engineering scaffolds. We explore if multi-lobed polymeric microparticles capable of self-assembling into a heterogeneous structure with designed pore dimensions can meet this need. The particles would be kept in the dispersed state until extruded through a 3-D printer at which point they would be subjected to a gelation mechanism and self-assemble into a porous macrostructure with targeted porosity. This gelation mechanism would utilize LCST (Lower Critical Solution Temperature) properties of polymer chains grafted onto the surface of the multi-lobed particles, allowing the particles to aggregate.. By controlling the dimensions of the lobes, and when/how they associate, we can assemble a macrostructure with designed porosity.

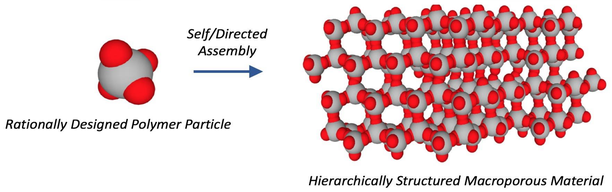

## Objective

The objective is to leverage the LCST properties[1] of polymer solutions to produce a thermally triggered aggregation of multilobed particles[2].



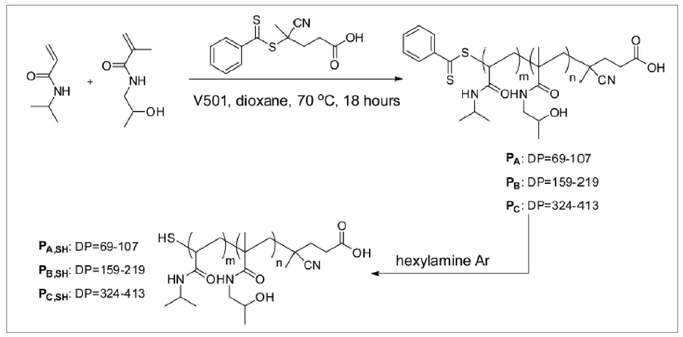



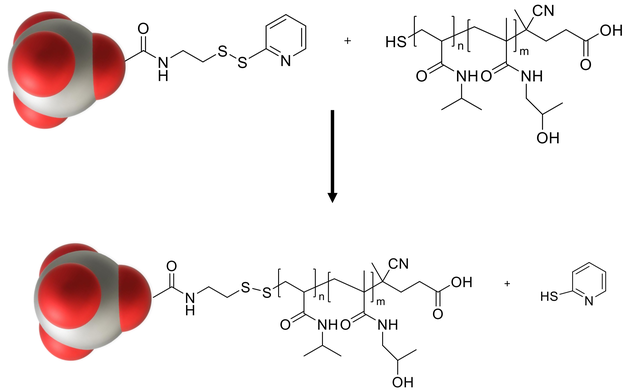



## Materials & Methods

RAFT polymerization of poly(NIPAM-co-HPMA)[3] and subsequent cleavage of Z group. Increasing %HPMA raises LCST.

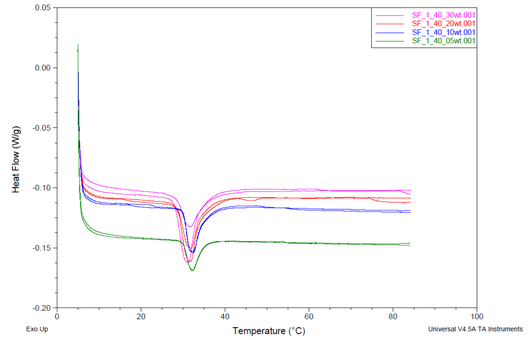


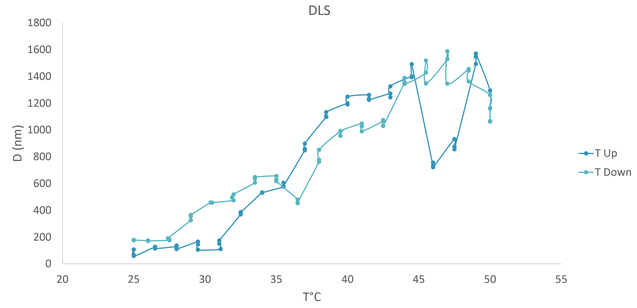

Grafting the new thiol terminated polymer onto a particles surface via disulfide functionalities



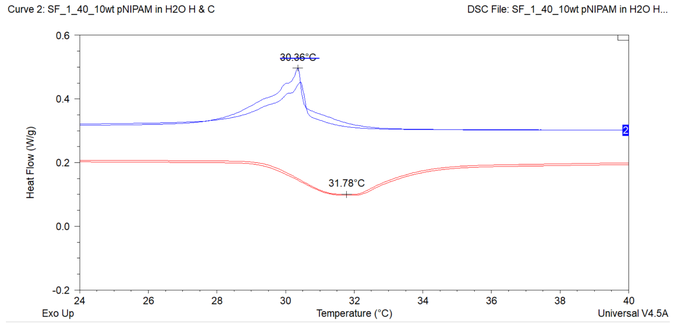
## Results & Discussion

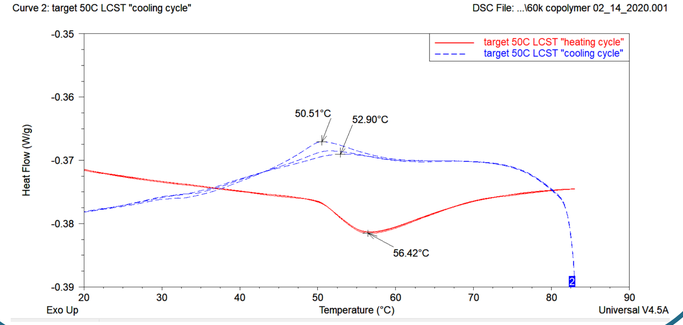
Differential Scanning Calorimetry (DSC) (top), is an accurate and precise method to measure LCST compared to other popular methods like Dynamic Light Scattering (bottom).




DSC results showing shift in LCST with adding higher %HPMA. PNIPAM (top) and 25 mol% HPMA poly(NIPAM-co-HPMA) (bottom).




## References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2. D. Blenner, J. Stubbs, D.C. Sundberg, "**Multi-lobed composite polymer nanoparticles prepared by conventional emulsion polymerization**," *Polymer*, **2017**, 54

3. B Luan, B.W. Muir, J. Zhuand, X. Hao, "**A RAFT copolymerization of NIPAM and HPMA and evaluation of thermo-responsive properties of poly(NIPAM-co-HPMA)"** *RSC Advances,* **2016**, 6, 89925


## Acknowledgements


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