STRUCTURAL CONTROL OF BI-POLYMER COMPOSED MICROPARTICLES FOR DRUG DELIVERY USING GLASS MICROFLUIDIC CAPILLARY DEVICES

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1. Introduction

- For the controlled production of uniform biodegradable microparticles from micro-droplets, the continuous dispersion of different organic phase droplets in an aqueous surfactant solution (emulsification) has been achieved via microfluidic methods with 3D (axisymmetric) glass capillary devices for drug encapsulation (Vladisavljevic et al., 2014; Ekanem et al., 2015).
- In this study, Janus poly(DL-lactic acid) (PLA)/ poly(caprolactone) (PCL) microparticles were produced by emulsifying polymer solution mixtures and subsequent internal phase separation initiated during solvent evaporation (Figure 1). Furthermore, uniform hemispherical PCL particles were obtained by dissolution of PLA domes with acetone.

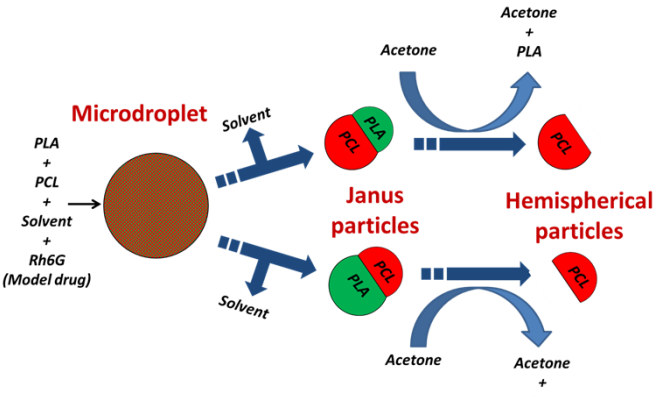

Figure 1. Bi-polymer Janus particles and hemispherical particle production.

2. Droplet Generation

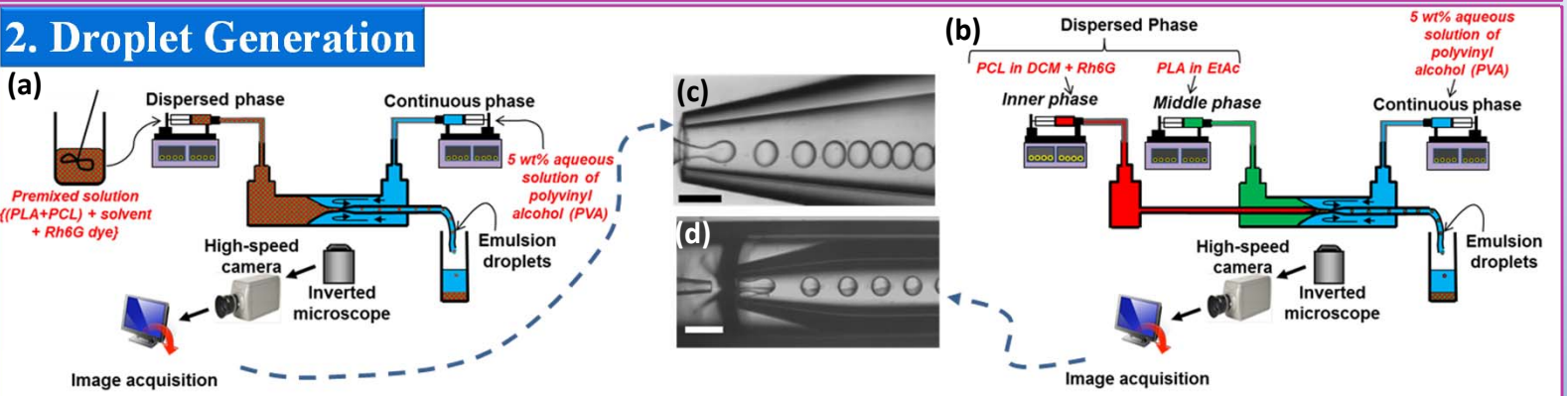

Figure 2. Microdroplets generation by (a) flow focussing a premixed polymer dispersed phase (b) simultaneous micro-mixing and flowfocussing of a polymer dispersed phase; (c) and (d) shows High-speed camera still images of both mixing methods. (Scale bars: (c) 250 µm (d) 570 µm). Polymer solvents used were Dichloromethane (DCM) and/or Ethyl acetate (EtAc) in both cases.

3. Polymer Particle Production

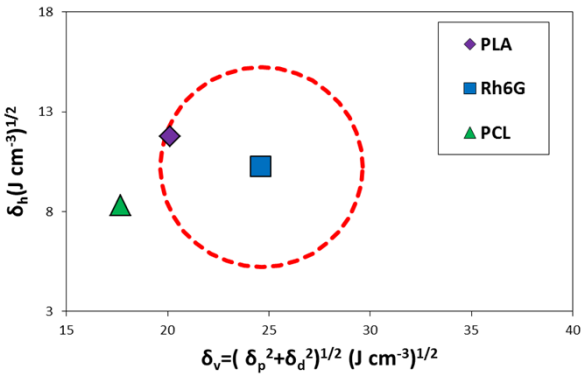

Figure 3. Bagley's two-dimensional graphs of partial solubility parameters . PLA in the solubility circle signifies Rh6G's higher preference for PLA than PCL.

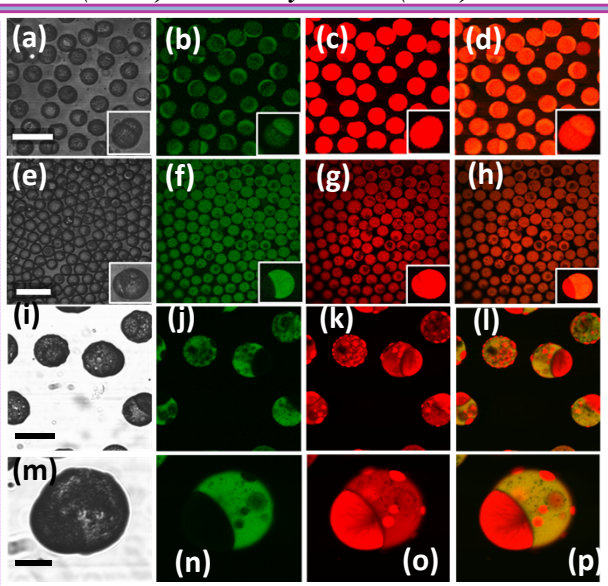

Figure 4. Confocal microscopic images of dyed polymer microspheres showing different PLA(Green) to PCL(Ratio) after phase. Scale bars: (a-d):50 µm; (e-h): 50 µm; (i-l): 100 µm and (m-p) : 50 µm

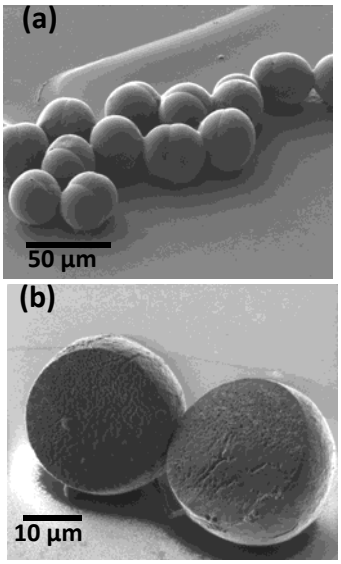

Figure 5. FIB images of (a) Janus particles with 1:2 (PLA: PCL) volume ratios. (b) PCL Hemispherical Microparticles.

4. Conclusion and Future Work

- Control of polymer ratio composition is achieved by the preferential sorption of Rhodamine 6G as a model drug to ascertain polymer distribution via by Confocal Laser Scanning Microscopy (CLSM).
- Future work would involve simultaneous bi-drug encapsulation and release mechanism studies/ monitoring.

References

- Ekanem, E. E., Nabavi, S. A., Vladisavljević, G. T., & Gu, S. (2015). ACS Applied Materials & Interfaces, 7(41), 23132–23143.
- Vladisavljević, G. T., Shahmohamadi, H., Das, D. B., Ekanem, E. E., Tauanov, Z., & Sharma, L. (2014), Journal of Colloid and Interface Science, 418, pp.163–70.

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