ME Seminar

Effect of mass transfer dynamics on the morphology of drug-loaded polymer microparticles

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ABSTRACT

Polymer microparticles are typically used as carriers of active pharmaceutical ingredients (drugs) in many sustained-release drug delivery treatments. Solvent extraction is a well-known industrial process for preparing such drug-loaded polymer microparticles. In this process, polymer solution drops are emulsified in a bulk aqueous medium and the solvent is extracted from the polymer solution drops, thus creating polymer microparticles loaded with the drugs of choice. The extraction rate of the solvent is a crucial parameter that impacts the morphology and the porosity of the microparticle, and these properties, in turn, affect the drug release kinetics. Hence, it is crucial to understand the effect of shear on the extraction rate and the morphology of the microparticle.

The primary goal of our work is to develop a systematic framework to study the dynamic change in the morphology of a polymer solution drop under continuous flow. We have used a Hele-Shaw microfluidic extensional flow device to hydrodynamically trap one drop at a time and observe the dissolution process under a constant strain rate. Using a mass transfer model, we determined that the extraction dynamics is primarily limited by the mass transport in the suspending aqueous phase. Based on the rate of solvent extraction and the rate of phase separation within the drop, we observed two types of morphologies – one in the form of a 'double-emulsion' configuration of the drug and the polymer, and the second in the form of a 'Janus' type of microparticle, and both these configurations are physically explained. The results obtained from these experiments will be instrumental in developing a comprehensive model capable of predicting extraction rates and polymer microparticle morphology, which can be applied across various drug manufacturing processes in the pharmaceutical industry.

ABOUT THE SPEAKER

Prof. Ramachandran obtained a Bachelor's degree in Chemical Engineering from the Institute of Chemical Technology (formerly University Department of Chemical Technology), Mumbai, India, in 2001 and a Ph.D. in Chemical Engineering in the area of particulate suspension rheology from the University of Notre Dame in 2007. He was a post-doctoral scholar in the Department of Chemical Engineering at the University of California at Santa Barbara from 2007-2010. He is currently a Professor in the Department of Chemical Engineering and Applied Chemistry at the University of Toronto. He directs the Laboratory of Complex Fluids, which works towards the establishment of fundamental knowledge in the fields of complex fluids and transport phenomena. Dr. Ramchandran is currently Canada Research Chair in Engineered Soft Materials and Interfaces.

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