In-Fiber Emulsification of Biodegradable Polymers for Drug Delivery

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A falling stream of water exhibits a phenomenon known as Plateau Rayleigh Instability (PRI) as it descends: initially taking the form of a fluid column, it eventually breaks up into spherical droplets as a direct result of varicose perturbations and surface tension. This study harnesses PRI as a mechanism for the synthesis of structured micro- and nanoparticles especially designed for drug delivery purposes. The particles are synthesized through a new In-Fiber Emulsification (IFE) process, consisting of the following steps: 1) a macroscopic cylindrical core-cladding preform is drawn into fiber using an optical fiber draw tower; 2) thermal treatment of the fiber induces fluid interface PRI, which emulsifies the fiber core into uniform spheres; 3) fabricated particles are extracted through selective dissolution of the fiber cladding. Although this process has been successful for producing glass and high-temperature polymer particles, the use of low-temperature, biodegradable polymers (the materials of interest for drug delivery applications) is unprecedented in both fiber drawing and IFE technology. Using Poly-Ethylene Oxide (PEO) and Poly Lactic co-Glycolic Acid (PLGA) as the cladding and core polymers, respectively, this study develops low-temperature IFE for the first time, in the synthesis of PLGA particles doped with a broad-spectrum antibiotic. Retention and efficacy of the incorporated antibiotic is confirmed at the fiber and particle stages through E. coli growth inhibition tests and optical-density-based drug release profiles. Incorporation of a fluorescent imaging agent into PLGA particles is also demonstrated. Thus, IFE is validated as a method of producing drug delivery particles, with exceptional potential in particle structuring for functional integration.

Awards Won:

Second Award of $2,000