In-Fiber Emulsification of Biodegradable Polymers for Drug Delivery, Year Two

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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, multi-material preform is drawn into fiber; 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. Following the development and establishment of IFE as a means of producing polymeric (PLGA), drug-loaded microparticles, this year's current research efforts focus on an integral advance in IFE technology. A newly designed structuring technique is implemented at the fiber preform stage, resulting in a multi-layer fiber composed of Polycaprolactone (PCL) and Polyethylene Oxide (PEO) polymers. Due to the nature of PRI, the fiber’s complex structure is inherited by the emulsified particles, which take the form of core-shell spheres. This added degree of structural complexity allows for functional compartmentalization within each particle, such that drugs, imaging agents, and other encapsulates can perform without interference. Ultimately, the ability to structure microscopic drug delivery vessels could result in potent treatment systems for cancer and other diseases.

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