Christophe A Serra, J Material Sci Eng 2014, 3:3
http://dx.doi.org/10.4172/2169-0022.S1.014

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference and Exhibition on
Materials Science & Engineering
October 06-08, 2014 Hilton San Antonio Airport, USA

Engineering polymer micro and nanoparticles with controlled size, composition and morphology by microfluidics

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Most conventional processes for the production of polymer particles imply heterogeneous polymerization processes (emulsion, suspension) or precipitation processes in a non solvent. Although these processes lead to polymer particles having a different size domain, the size is very sensible to the operating parameters and cannot readily be adjusted, not to mention the large particle size distribution which is often observed. Recently, microfluidic processes have been considered because of their unique capacity to generate microdroplets with a very narrow size distribution. Thus, if the microdroplets generated are polymerizable liquids, it is possible to obtain polymer particles with well-defined characteristics like size, shape and morphology. Here the latest developments on microfluidic processes for the production of sized-, composition- and morphology-controlled polymer micro and nanoparticles will be presented.

Capillary-based flow-focusing and co-flow microsystems were developed to produce polymer microparticles of adjustable sizes in the range of 50 to 600 μm with a narrow size distribution (CV<5%), different shapes (spheres, rods) and morphologies (core-shell, janus, capsules). Influence of operating conditions (flow rate of the different fluid, microsystem characteristic dimensions and design) as well as material parameters (viscosity of the different fluids, surface tension) was investigated. Empirical relationships were thus derived from experimental data to predict microparticle overall size, shell thickness or rods length.

Besides the morphology, microparticles with various compositions will be presented and their potential applications: drug loaded micro and nanoparticles for new drug delivery strategies, composed inorganic-organic multiscale microparticles for sensorics and liquid crystalline elastomer microparticles showing an anisotropic reversible shape change upon temperature for thermal actuators or artificial muscles will be emphasized.

Biography

Christophe A Serra is Professor at the University of Strasbourg teaching at the European School of Chemistry, Polymers and Materials Science (ECPM). He received his MS and PhD degrees in Chemical Engineering from the National Engineering School of the Chemical Industries (Nancy) and Paul Sabatier University (Toulouse), respectively. His researches concern the development of intensified and integrated microfluidic-assisted polymer processes for the synthesis of architecture-controlled polymers and functional microstructured polymer particles.

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