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Small is big: magic microfluidic droplets

Droplets of nanoliter and subnanoliter are useful in a wide range of applications, particularly when their size is uniform and controllable. Examples include biochemistry, biomedical engineering, food industry, pharmaceuticals, and material sciences. One example of their many fundamental medical applications is the therapeutic delivery system for delivering site-specific therapy to targeted organs in the body and as the carriers for newer therapeutic options. The size, the size distribution, the generation rate and the effective manipulation of droplets at a scale of nano, pico, femto and even atto liters are critical in all these applications. We make an overview of microfluidic droplet generation of either passive or active means and report a glass capillary microfluidic system for synthesizing precisely controlled monodisperse multiple emulsions and their applications in engineering materials, nanofluids, microfibers, embolic particles and colloidosome systems. Our review of passive approaches focuses on the characteristics and mechanisms of breakup modes of droplet generation occurring in microfluidic cross-flow, co-flow, flow-focusing, and step emulsification configurations. The review of active approaches covers the state-of-the-art techniques employing either external forces from electrical, magnetic and centrifugal fields or methods of modifying intrinsic properties of flows or fluids such as velocity, viscosity, interfacial tension, channel wettability, and fluid density, with a focus on their implementations and actuation mechanisms. Also included is the contrast among different approaches of either passive or active nature.

Biography

Liqiu "Rick" Wang received his PhD from University of Alberta (Canada) and is currently a Full Professor in the Department of Mechanical Engineering, the University of Hong Kong. He is also the Qianren Scholar (Zhejiang) and serves as the Director and the Chief Scientist for the Laboratory for Nanofluids and Thermal Engineering, Zhejiang Institute of Research and Innovation (HKU-ZIRI), the University of Hong Kong. He has over 30 years of university experience in thermal & power engineering, energy & environment, transport phenomena, materials, nanotechnology, biotechnology, and applied mathematics in Canada, China/Hong Kong, Singapore and the USA, and 2 years of industrial experience in thermal engineering and technology management. He has secured over 70 projects funded by diverse funding agencies and industries including the Research Grants Council of Hong Kong, the National Science Foundation of China and the Ministry of Science and Technology of China, totaling > US$ 15m (excluding US$ 2.2 billion for AMS project). He has published 10 books/monographs and 356 book chapters and technical articles, many of which have been widely used by researchers all over the world, and is ranked amongst the top 1% of most-cited scientists (ESI). He has also filed 22 patent applications and led an international team in developing a state-of-the-art thermal control system for the Alpha Magnetic Spectrometer (AMS) on the International Space Station.

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