Duke University
Office of Licensing & Ventures
Technology Opportunity

PROGRAMMABLE LIQUID, GEL, AND BIOHYBRID COMPARTMENTS

File #

Application

While multi-phase compartments are ubiquitous within cells, provide a powerful method for segregation of biomolecules, and are universal motifs in particle fabrication, a broad platform for the programming of complex and hierarchical structures has remained elusive. Existing microfluidic and existing bulk techniques for hierarchical liquid-liquid and particle systems are severely lacking in scalability, size control, ease of fabrication, or morphological diversity. Our invention provides the ability to program the self-assembly of hierarchical liquid and polymeric compartments evolved from homogeneous solutions, suspensions, and cellular components by encoding physicochemical behavior at the building block stage. The ability to encode information needed for programmable self-assembly of liquid compartments into complex patterns is a hallmark of biological materials; emulating and harnessing these features allows for the formation of highly functional and well-defined structures. Our approach is differentiated from existing technologies because (i) it affords the autonomy to program the complex structuring of diverse biological and synthetic materials spanning multiple size scales, and (ii) it is amenable to scale up.

This approach enables us (1) to evolve single- and mixed-population liquid and polymeric compartments spanning the nano-, meso-, and microscale, and (2) to evolve multilayered architectures by controlling phase behavior. Furthermore, these complex structures are fully reversible; by simply removing the external stimulus (e.g. temperature, pH, ions, light) the system returns to its initial state. We have demonstrated our approach by creating multi-component protein compartments; these structures represent a step towards recreating complex non-membrane bound intracellular-like microenvironments through controlled segregation of bio macromolecules. Our technology will enable high-throughput, one-pot fabrication of complex hierarchical biological and synthetic particle architectures through preprogrammed phase separation and self-assembly. The self-assembled nano, meso, micro and macro structures enabled by our approach may find utility in drug delivery, as intra- and extracellular switches, protocells, bioanalytical systems, biomanufacturing, tissue engineering, and drug discovery.

Technology

Researchers at Duke University have developed a platform to program the assembly of proteins and polymers into complex particle architectures. The Duke approach enables programming of materials at the building block level, which is implementable over a large range of size, production scales and applications.

Intellectual Property

Patent application

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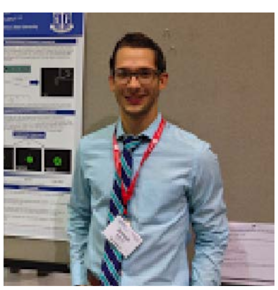
Inventors

Gabriel P. Lopez, Ph.D., is a Professor of Biomedical Engineering and Professor of Mechanical Engineering and Materials Science at Duke University. He also serves as Founding Director of the National Science Foundation's Research Triangle Materials Research Science and Engineering Center (Triangle MRSEC). Dr. Lopez's primary professional interests lie in research and education in biomaterials science and engineering, bioanalytical chemistry and biointerfacial phenomena.

Ashutosh Chilkoti , Ph.D., Ashutosh Chilkoti is the Theo Pilkington Professor and the Chair of the Department of Biomedical Engineering at Duke University. His research in biomolecular engineering and biointerface science focuses on the development of new molecular tools and technology's that borrow from molecular biology, protein engineering, polymer chemistry and surface science.

Nick J. Carroll, Ph.D., is an Assistant Research Professor of Biomedical Engineering at Duke University. He is also a principle investigator with the National Science Foundation's Research Triangle Materials Research Science and Engineering Center (RTMRSEC). Dr. Carroll's research focuses on soft matter chemistry and physics, self-assembled polypeptide and polymeric micro- and nanoparticles and microfluidic fabrication of hierarchical colloids.



Joseph R. Simon, is a graduate students in Professor Gabriel Lopez's lab. His research explores the development of hierarchical, stimuli responsive materials and materials systems. In particular, he is interested in developing new polypeptide-based materials platforms that exhibit 'smart' behavior

Contact

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