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JACOBS SCHOOL OF ENGINEERING
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UC SAN DIEGO NANOENGINEERING SEMINAR

Wednesday, February 28 2018
Seminar Presentation: 11:00am – 12:00pm
ASML Conference Center (SME 248)

"Engineering of Responsive Functional Soft Matter: Smart Particle Gels, Self-Propelling Microbots and Biomimetic Hydrogel Devices"

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Abstract: We will present strategies for field-driven assembly and manipulation of novel functional structures from soft matter, including dynamically reconfigurable assemblies of particles or hydrogels. First, we will present magnetically responsive and self-repairing gel networks, and inks for 3D printing, based on multiphasic liquid/liquid/solid systems. The gel system is made of filaments from super-paramagnetic iron oxide nanoparticles, coated by lipid shells, and dispersed in water. The field assembles the nanoparticles into filaments by magnetophoresis, while their lipid shells form nanocapillary liquid bridges. The nanocapillary binding allows for easy particle rolling and sliding, resulting in ultra-high filament flexibility. These principles were applied in the development of new 3D printing inks consisting of water and two silicone-based components: crosslinked PDMS microbeads and non-crosslinked liquid PDMS. In the second part of the talk we will discuss how metallo-dielectric Janus/patchy spheres and microcubes acquire complex polarization patterns in external fields, leading to multidirectional interactions and assembly. We will describe how magnetically responsive Janus microcubes can be assembled hierarchically into dynamically reconfiguring microclusters and chains. The residual polarization of the metal-coated facets leads to magnetic interactions and reconfiguration, directed by the orientational sequence of the microcubes. The pre-assembled clusters can be reversibly actuated, oriented and spatially transported by magnetic fields. They can be designed to be self-motile in media with non-Newtonian rheology. They are also capable of grabbing and transporting target micro-objects and serve as prototypes of microbots and colloidal origami. Finally, we will discuss how similar field-driven effects of particle structuring, ionic transport and electroosmotic actuation can be applied in hydrogel-based biomimetic actuators for soft robotics and skin-interfacing wearable devices.

Biosketch: Dr. Orlin Velev received M.Sc. and Ph.D. degrees from the University of Sofia, Bulgaria, while also spending one year as a researcher in Nagayama Protein Array Project in Japan. After graduating in 1996, Velev accepted a postdoctoral position with the Department of Chemical Engineering, University of Delaware. He initiated an innovative program in colloidal assembly and nanomaterials and was promoted to research faculty in 1998. In 2001 formed his new research group in the Department of Chemical and Biomolecular Engineering, North Carolina State University, where he was promoted to INVISTA chaired professor in 2009. He has contributed more than 190 publications, which have been cited more than 19,000 times, and has presented more than 230 invited presentations at major conferences and at universities and companies. His awards include among others NSF Career, Camille Dreyfus Teacher-Scholar, Sigma Xi, NC State Alcoa Distinguished Engineering Research, NC State Alumni Distinguished Undergraduate Professor, NC State Innovator of the Year, Springer Colloid and Polymer Science Lecture Award, NC State R.J. Reynolds Award for Excellence and AIChE Andreas Acrivos Award for Professional Progress. Velev has been elected to an ACS Fellow and MRS Fellow.

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