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# EML WEBINAR


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## DROPLETS THAT STIFFEN GELS


Soft composite materials exhibit mechanical properties that emerge from interactions between embedded inclusions and their surrounding matrix, yet the large design space has hindered development of predictive design principles. Here we introduce a model composite consisting of phase-separated DNA droplets embedded with entangled actin networks, combining a highly-programmable liquid inclusion system with a filamentous hydrogel matrix with well-understood mechanics, and orthogonal biochemistry. We find an unexpected structural organization in which DNA droplets condense around (and are interpenetrated by) the actin meshwork, in contrast to exclusion or wetting behaviors reported for other analogous systems. This distinct morphology leads to a novel mechanism of matrix control of droplet size that is in quantitative agreement with scaling predictions. Further, mechanical measurements show that the droplets induce an extraordinary (more than ten-fold) stiffening of the composite, vastly exceeding what is expected based on classical predictions. We propose this is due to a clamping effect of the droplets on the actin that mechanically entrains the droplet-adjacent matrix, increasing the effective size of the inclusions. Together these results reveal a passive chemo-mechanical feedback loop in which the actin network controls droplet structure while the droplets reciprocally regulate network mechanics. More broadly, our work establishes a versatile model system for investigating soft composite materials, and identifies new physical mechanisms for engineering the structure and mechanics of soft matter.


**Omar Saleh** is Professor at UC Santa Barbara, where he develops experimental and theoretical approaches to uncover the molecular physics of biological and soft-material systems. His research spans nucleic acids, protein/DNA interactions, motor proteins, biomolecular elasticity, self-assembled biomolecular systems, and biomolecular condensates. His work has advanced the understanding of how molecular-scale interactions give rise to the emergent mechanical and structural properties of biological materials. Saleh received his BS in Physics from MIT and his PhD in Physics from Princeton University as a Hertz Fellow. He was then a postdoctoral fellow at the École Normale Supérieure in Paris, where he developed single-molecule techniques to study motor protein/DNA interactions. He joined UC Santa Barbara in 2005, where he is now Chair of the Materials Department, and is a Fellow of the American Physical Society.

Discussion leader: **Robert M McMeeking**, University of California, Santa Barbara

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