Bioinspired Molecular Composites of 2D-Layered Materials and Tandem Repeat Proteins

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Composite materials have been prevalent in the industry for the past decade, yet nature has utilized composite materials long before human applications due to evolutionary optimizations. Nature's limited material selection is counteracted by sophisticated structural hierarchy that optimizes for strength and resilience. We sought to expand that material selection and mimic natural hierarchy to achieve composites with extraordinary properties. Brick-and-mortar composites are an example of such hierarchy in nature that can be observed in the mother of pearl shells and bones. Our research focuses on similar composites of Graphene Oxide (GO) and Squid Ring Teeth (SRT) protein. In a previous study, we discovered the importance of interfacial interactions and how the aspect ratio of the filler affects the mechanical behavior of brick-and-mortar composites. To further investigate our findings, we are currently using Molecular Dynamics (MD) simulations to match our experimental results to model the mechanical behavior of these composites. The results of our simulations will bridge the gap between the bulk properties that were observed in the lab with the molecular interactions in the simulations to explain the deformation mechanism of brick-and-mortar composites on a multi-scale basis.